CEMENT AND ITS USES

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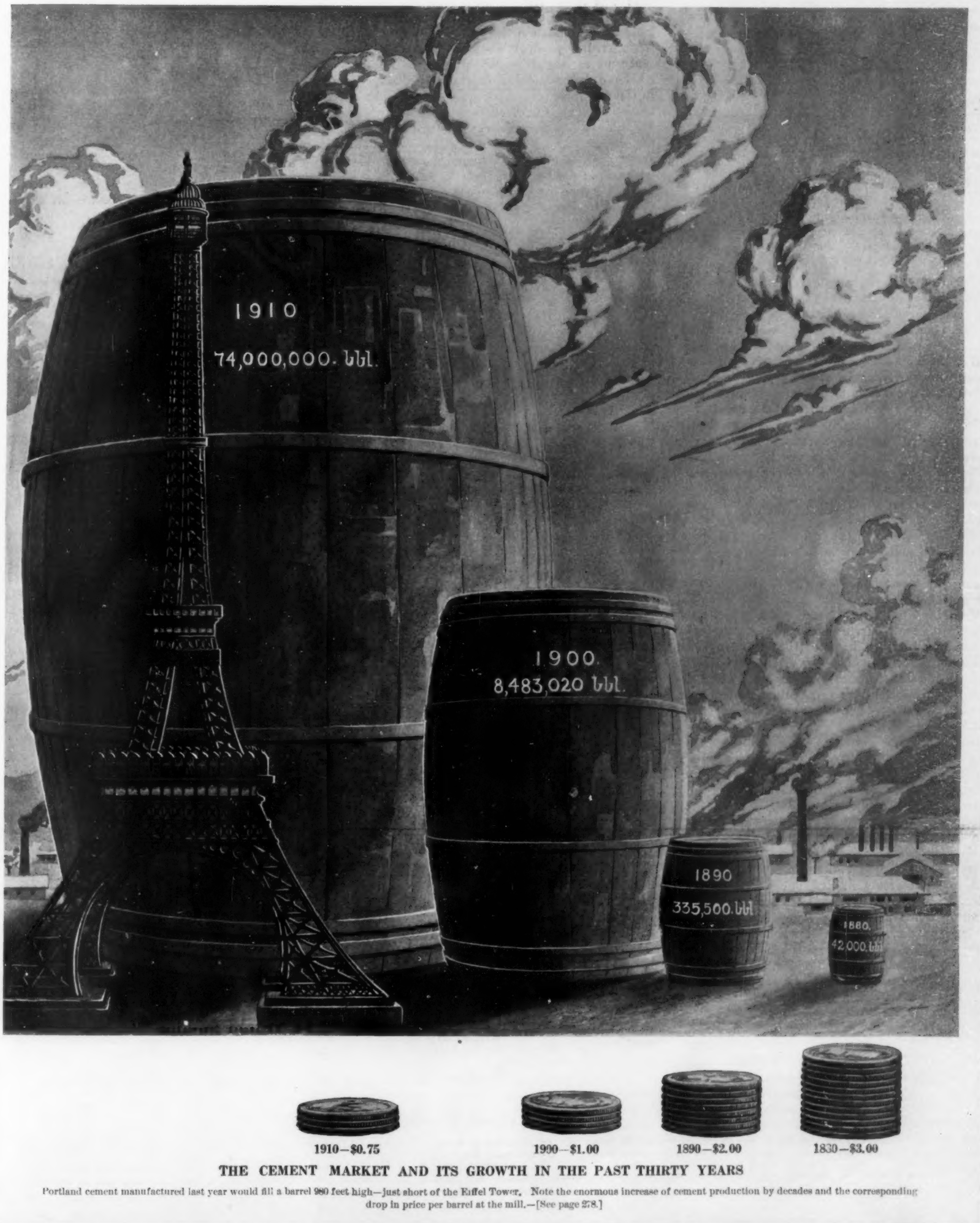

THE CEMENT MARKET AND ITS GROWTH IN THE PAST THIRTY YEARS

Portland cement manufactured last year would fill a barrel 980 feet high—just short of the Eiffel Tower. Note the enormous increase of cement production by decades and the corresponding drop in price per barrel at the mill.—[See page 278.]

SCIENTIFIC AMERICAN

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The Editor is always glad to receive for examination illustrated articles on subjects of timely interest. If the photographs are *sharp*, the articles *short*, and the facts *authentic*, the contributions will receive special attention. Accepted articles will be paid for at regular space rates.

The purpose of this journal is to record accurately and in simple terms, the world's progress in scientific knowledge and industrial achievement. It seeks to present this information in a form so readable and readily understood, as to set forth and emphasize the inherent charm and fascination of science.

The Cement Era

IT seems to be generally agreed, and we think with much reason, that the year 1911 should mark the centenary of cement, or, to speak more strictly, of Portland cement. This selection is due to the fact that Joseph Apsdin was born in 1811, and that it is to his intelligence and patience that we owe our modern hydraulic cement. History fails to establish the exact date of the first production and use of this great modern material of construction, for it is a fact that Apsdin who was a brickmaker in Leeds, Yorkshire, spent a dozen years or more in experimental work before he covered his invention with a patent, and nearly three times that period elapsed before his discovery received its adequate recognition. Incidentally, it may be mentioned that the inventor gave to the new cement the name of Portland, because it resembled a building stone very widely used in England, which is obtained from the limestone quarries at the Isle of Portland, in Dorsetshire. The "isle," by the way, is not an island, but a rocky peninsula, extending into the English Channel and connected to the mainland by a long, curving beach.

It has long been the habit of the historian when speaking of the constructional or mechanical side of human progress to name its various eras after the predominant materials of construction. Hence, in their succession, we have had the eras of stone, bronze, iron, and steel. To-day we find ourselves well launched in what may justly be called the era of cement.

Let it be clearly understood, just here, that cement is many centuries older than Joseph Apsdin's Portland cement. Long before the Christian era, the Egyptian and the Roman builders were familiar with a form of concrete, compounded from certain natural limes, clays, and rocks (generally volcanic) or gravel. Those wonderful engineer-architects, the Romans, laid it freely in the foundations of their temples, and did not hesitate to make bold use of it, both in dome and arch. The concrete of the ancients, however, was of a slowly-setting nature, requiring considerable time to reach the great hardness, which characterizes such of it as still survives.

The valuable quality of Apsdin's invention lay in the fact that he produced a mechanical mixture which, when treated with the proper amount of water, will harden in a short space of time, either in air or under water; and although his discovery did not receive its due recognition until the middle of the nineteenth century, this wonderful method of making an artificial stone, compounded of simple, easily obtainable and cheap ingredients, was clearly set forth. Subsequently, the cement industry awaited the development of another great industrial art, that of steel making, which was destined to place it in its present position as the greatest of the world's constructive materials for works of magnitude.

For all uses to which ordinary masonry can be put, cement, when mixed in the proper proportions with sand and broken stone or gravel, forms an admirable and, if properly finished, a not unsightly building material. But like any other system of masonry construction, while it is capable of enduring heavy strains of a compressive nature, it is ill-adapted for those of tension. Hence concrete necessarily has a very limited range of use in structures in which heavy tensional and bending stresses will occur, as, for instance, in beams or girders, in arches of flat span subjected to uneven loading, or in posts or columns where structural requirements call for a small ratio of diameter to length.

About the time that concrete was beginning to receive its due recognition, the great Bessemer, by inventing his process of decarburization, so far improved the quality and reduced the cost of steel, that it quickly replaced iron and introduced that wonderful commercial steel, which has been the most potent factor in the marvellous industrial development of the past half century.

It was about fifteen years ago that serious attempts were made to combine steel and concrete by molding the one into the other in such a way that the resulting product would possess a high resistance not merely to compressive but to bending and tensional stresses. The first practical experiments in this direction gave such good results that the attention of engineers throughout the world was quickly centered upon the problem. A vast amount of experimental work was done, out of which has sprung our modern reinforced concrete, regarding which it is not too much to say that it is destined to play a part in engineering construction, second only, if not equal, to that of mild steel. The developments of the past fifteen years, particularly of the last five, have been truly phenomenal. Not only is concrete found to be available for practically every form of construction which hitherto has been built in brick or stone, not only has it proved well adapted for many uses in which neither brick nor stone is conveniently available, but it has now invaded the field which was supposed to be peculiarly reserved for iron and steel, as witness the fact that it is being used for piling, for tanks, for trussed bridges, for framed roofs, and for flooring of wide span. Most significant and incredible of all, it is taking the place of steel in the construction of certain types of boats and small barges and ships. In works of great magnitude involving a large amount of construction, it has proved to be simply invaluable; and it can truly be said that were not concrete and reinforced concrete available, that most monumental of all modern engineering works, the Panama Canal, could never have been undertaken by the United States.

It will be admitted, then, that the present issue of the SCIENTIFIC AMERICAN, the greater part of which is devoted to the subject of Portland cement, is particularly timely, both because of the vast advances which are being made in the application of this material, and because of the fact that the present year is the centenary of the birth of its original inventor. In the selection of the subjects in the various chapters, we have aimed to give a clear and consecutive account of this material, tracing its history from the ancient cement compounded of natural materials, down to the Portland cement of modern times.

It is a rather curious fact that while Portland cement enters so largely into our modern life, there are few people outside of those connected with its manufacture and constructive use who know just exactly what Portland cement is. The question is answered in an article which takes the reader, step by step, through an up-to-date cement factory. Of no little interest will be the article showing how the price of cement has fallen steadily as its use has become more extended. Every prospective builder of a home must be more or less concerned in the subject of the monolithic cement house, and he will find in this issue a description of this original method of house building by pumping the mixture into special forms. For those who may have a prejudice against concrete as a material for house building, on the ground of its liability to dampness, the article by an expert in waterproofing materials will have particular value; and, again, for those who may object to cement on the ground of its color, to say nothing of its discoloration, the article on the artificial coloring of cement and the admirable results to be obtained in reproducing the natural stone effects, will be entertaining, if not convincing. The larger side of the subject, as applied to works of magnitude, is treated in an article on the Panama Canal, in which the methods adopted in gathering the 5,000,000 cubic yards of rock, sand, and cement together, mixing them, and building them in place, are described with the aid of a series of the latest photographs published by the courtesy of the Isthmian Canal Commission.

The Scientific American in the Canadian Parliament

THE Hon. George P. Graham, Minister of Canadian Railways, during a recent discussion in the House of Commons of the subject of the Quebec bridge, in referring to certain criticisms, made by this journal, of the government's design for the new structure, referred to the SCIENTIFIC AMERICAN as being of the "knocking" variety.

Now, although the SCIENTIFIC AMERICAN covers a fairly wide field, we have to admit that among the variety of subjects which come up for editorial analysis and discussion, that of slang is happily, or, as in the present case, unhappily, not included. We say, unhappily, for if we were expert in the refinements and delicately shaded graduations of the slang dictionary, we might have a clearer knowledge than we possess of just what was in the Hon. Mr. Graham's mind when he spoke of this scientific journal as being of the "knocking" variety.

In the absence of any definite information, we have concluded that our criticisms, technical and otherwise, of the government design for the Quebec bridge, do not find favor in the eyes of the Hon. Mr. Graham, nor of his chief engineer, upon whose shoulders, we understand, the responsibility for the design must be placed.

If we were to venture on a definition of a "knocker," we would describe him as one who has fallen into a chronic attitude of destructive criticism; one whose fault-finding is prompted by a certain twisted mental attitude, which takes but small account of the merits of the question involved. Now, as a matter of fact, the attitude of this journal to great public works, has invariably been one of generous appreciation. At the same time, however great the work might be, however distinguished the names that were back of it, we have never hesitated, when occasion called for it, to criticise with freedom and, as in the present case, with severity.

Thus, in the case of the Quebec bridge, we printed in our issue of February 12th, 1910, a plan and a description of the design which had been drawn up by the Quebec bridge board for the new structure. We took exception to the design on the ground that it was not only of inferior merit, considered from the bridge engineer's standpoint, but that, if constructed, it would be the ugliest bridge of monumental proportion among those hitherto proposed or built. "It presents," we said, "the appearance of a monotonous mesh of triangles and straight lines. From abutment to abutment, there is not one graceful line in the whole structure; not the slightest attempt to combine the beautiful with the useful. The faulty structure which collapsed had at least the redeeming feature, that the outlines were structurally and aesthetically correct; and, although the Forth bridge has been made the subject of much criticism by the artist and the architect, it must be regarded as having distinct claim to beauty, when compared, as on the accompanying page, with the new plans for the Quebec bridge."

That was our attitude on February 12th, 1910, and the events of the past twelve months have produced nothing that would lead us to change our opinion. Furthermore, the dissatisfaction which we expressed with the plans of the Quebec Bridge Board, and which, in the Hon. George P. Graham's mind, is technically defined as "knocking," seems now to be shared by the expert board which has recently passed upon the design in question; for, at a recent ballot, four votes were cast against it and but one, that of the engineer chiefly responsible for the production, was cast in its favor,—the result of this action being that this gentleman has resigned.

Since this matter of the attitude of the SCIENTIFIC AMERICAN to this great engineering work has been called in question by a member of the Canadian government speaking in the House of Commons, we feel impelled to state, once and for all, that our attitude in this matter is one of disinterested friendliness. Our great neighbor to the north is about to undertake the re-construction of a bridge which, upon its completion, will rank as the most monumental work of its kind in the world. Apart from its economic value as forming a great link in the means of communication between Canada and the United States, the Quebec bridge will, or at least should, stand as a monument to the enterprise and engineering skill of the Canadian people. The SCIENTIFIC AMERICAN criticised the government's design on the ground that it would fail in these very regards. We believe that plans can be drawn, upon which a noble bridge can be thrown across the St. Lawrence river at Quebec, which will be lighter, more secure, possess greater dignity and beauty, and be erected for far less cost than the very crude and clumsy design that has recently been voted down by a majority of the government's own expert Board.

Jacobus Henricus van't Hoff

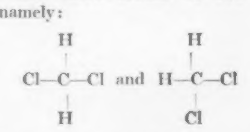
Founder of Stereochemistry and of the Modern Theory of Solution

FOR the second time, while the year is still young, the world of science mourns the loss of a great leader. Van't Hoff, who, by his investigations on osmotic pressure and related phenomena in the middle of the eighties, laid a very cornerstone in the foundations of physical chemistry, is no more. Born in 1852 at Rotterdam, the son of a practising physician, he received his first education at the "Burgerschool" of that city. The curriculum of schools of this type does not include the study of Greek and Latin. Ostwald, whose views on the uselessness of teaching dead languages are well known, takes occasion, in a biographical sketch of Van't Hoff, to point out the brilliant vindication which the great master has wrought for the "non-classical education." Van't Hoff, himself, humorously refers to his ignorance of the Roman tongue in replying to a Latin quotation from Bacon, which an opponent had launched at him in criticism of views now quite generally accepted. The great chemist remarks that this criticism cannot possibly cause him any uneasiness of mind, since he does not understand Latin.

In 1869 van't Hoff entered the Polytechnikum at Delft, where he completed the regular three years course in two. He then proceeded to the University of Leyden, to which he was admitted without examination by special ministerial permit. He subsequently studied under the great Kekulé at Bonn and under Würtz at Paris. In 1874 he received his doctor's degree at Utrecht, where he also began his teaching activities in 1876. Only a year later he was called to Amsterdam, to be shortly after promoted to a professorship. In 1894 he accepted the appointment at Berlin which he retained to the end of his active life.

The work of Van't Hoff is distinguished, not so much by great volume, as by the extraordinary force and originality of his conceptions and the supreme importance of the principles which he brought to light and enunciated.

His first great achievement lay in the field of organic chemistry. To properly appreciate it, we must carry our minds back to the year 1874, and recall some of the circumstances that prepared the way for Van't Hoff's *coup d'ésprit*. At that time organic chemistry was well advanced. The tetravalency of carbon was fully established, and graphic formulæ similar to those of the present day were in use. It had been observed, however, that there were certain peculiar cases of isomerism which could not be accounted for by the formulæ as ordinarily written. To illustrate the point, we must note first of all that a formula written on paper, and therefore necessarily in two dimensions only, in some respects fails to represent observed facts. Thus, if we write out graphically the formula for dichlor-methane it appears that there should be two isomeric forms, namely:

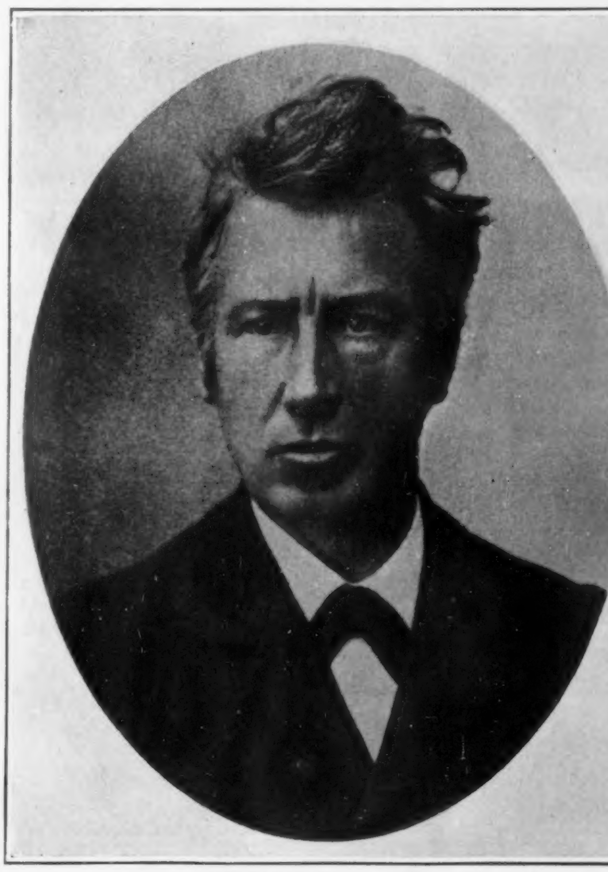


In point of fact there is only one such body. Thus the representation in plane formulæ in such a case would indicate a greater variety of forms than actually exists. In other instances the reverse is the case; a plane formula is incapable of properly establishing the distinction between forms which are actually known in practice. The whole situation was cleared at one stroke by van't Hoff when he pointed out that to properly represent the facts three-dimensional formulæ must be used. Closely connected with this matter is the phenomena of optical activity. It had been known for many years that certain solids and liquids have the property of turning the plane of a beam of polarized light transmitted through them. The genius of Pasteur had shed a new light on the subject. He showed that optical activity was closely bound up with asymmetry in crystalline form, and concluded that optically active organic compounds have "asymmetric molecules." Wherein this asymmetry lay was left for van't Hoff to discover. It was he who pointed out that in the molecule of every optically active carbon compound there is one carbon atom linked to four different groups. When a model in three dimensions of the molecule of such a compound is made, it is found that there are two possible arrangements of the groups clustered about the carbon atom. The relation between these two arrangements is such that the one is the mirror-image of the other, or in other words, the two forms are related to each other in the same way as a man's left hand is to his right. The representation of chemical formulæ in space—stereochemistry as it is called—thus fully accounts for a host of instances of what is known as optical isomerism, that is to say, the existence of pairs of compounds, the one member of each pair being practically identical to the other in all its properties, except that the one rotates polarized light to the right, the other has an exactly equal rotation to the left.

It is a rather curious fact, so frequently observed in the case of great scientific discoveries, that the same principle was recognized and published in the very same year, 1874, by the French chemist Le Bel, working quite independently.

Far-reaching as the influence of van't Hoff's conception has been in the development of organic chemistry, one hardly hesitates to say that of still more fundamental importance are his contributions to physical chemistry. To him is due much of the credit of the detailed working out of the results which flow from the law of mass action. By him the application of thermodynamics to physical chemistry, first applied to isolated cases by Horstmann, was greatly extended, so as to bring to light among other things the influence of temperature upon chemical equilibrium. The result is expressed qualitatively in the well-known van't Hoff principle of mobile equilibrium: "The state of equilibrium of a chemical system is by a rise in temperature shifted in the direction in which the reaction proceeds with absorption of heat." Further extensions of this principle were subsequently given, one in the same year by Le Chatelier, and the other three or four years later by Braun.

Perhaps most important of all is van't Hoff's contribution to our knowledge of solution. By far the most numerous chemical reactions in which we are technically or otherwise interested take place in solution. For this reason alone the clearing of the view by a thoroughly satisfactory theory of solution represents an immeasurable gain to science, pure and applied. To fully realize the almost unparalleled significance of van't Hoff's elucidation of the laws of solution, we must bear in mind that these form at the same time the foundation for the modern theory of electrolysis and ionic dissociation. The limitless field of electro-chemistry, with its remarkable practical applications, is intimately connected with the phenomenon of solution.



Prof. J. H. van 't Hoff

The law of solution, as developed by van't Hoff, is striking and beautiful in its simplicity: the osmotic pressure of a dissolved substance is equal to the gaseous pressure which that substance would exert if occupying the given volume at the given temperature, but in the form of a gas. The law is of course only approximate, holding only for dilute solutions; in the case of electrolytes allowance must also be made for dissociation.

Following out naturally the trend of his work, van't Hoff next (1885) broached the field of "solid solutions," which has proved of much importance in connection with the metallography of steel. The related subject of crystallization of salt-mixtures from saturated solutions forms the subject of his last great series of investigations, carried out in collaboration with Meyerhoffer and others. This subject is of special interest in connection with the phenomena presented in the evaporation of sea water and the formation of deposits, such as the famous salt strata at Stassfurt, in past geological epochs. By a systematic study of the conditions under which different salts are laid down from solution, it is possible to establish a kind of "geological thermometer," which gives us a clue as to the temperatures which prevailed at the time the deposits were formed. There are evidences of a temperature as high as 70 deg. C. having been reached at Stassfurt.

Such, in brief review, are some of the bequests which van't Hoff has made to modern science. As we pay the last honors to the great departed, we wonder in our mind who shall be the young men of genius to fill the places left vacant by the passing of the older generation.

The Advance of Plant Life

WHEN, years ago, there occurred the tremendous volcanic explosion in the Straits of Sunda, "the biggest noise the world ever heard," half of the island of Krakatoa was blown away, and every vestige of life was destroyed on the remaining half. The ground was buried under hot ashes and burning pumice stone, varying in depth from three feet to nearly two hundred feet. No vegetable germ could possibly have survived the catastrophe. Yet, only three years after the eruption, when Krakatoa was explored, various species of plants were found flourishing there.

It was shown that they could not have been carried there by human agency, because men had not visited the devastated island. The character of the new plants was such as to prove that they could not have been derived from the former vegetation of Krakatoa, even if any living remains of that vegetation could have existed in the burned and buried soil.

The nearest land on which any plants grew was the island of Sibesie. Sumatra is twenty miles and Java twenty-one miles from Krakatoa. Yet a dozen kinds of ferns and several species of flowering plants and grasses were discovered by Treub flourishing on the shore and in the mountainous interior. That some of these forms of vegetation had been carried there by the ocean was indicated by the fact that seeds of littoral plants were found scattered on the shore.

As to the other plants, the history of their appearance upon the island seems to have been as follows: First, a thin film of a simple form of vegetable life, derived from floating germs in the atmosphere, covered the pumice stone and, through chemical action, brought its surface into a condition fitted for the nourishment of ferns and later of flowering plants. The seeds of these were brought by the winds and birds and, as soon as the soil was capable of supporting them, they took root and, bathed in the equatorial sunshine, began the work of clothing the barren island anew.

Renewed attention has recently been called to this reappearance of vegetation on Krakatoa in connection with the general subject of the origin of plants that inhabit islands. Nature shows herself entirely capable of conveying the germs of plant life for long distances by means of the ocean and the atmosphere, aided by the birds. When man comes to her assistance, the work goes on apace.

Of more than eighty species of plants inhabiting the Laccadive Islands, which are simply the tops of a group of submerged mountain peaks in the Arabian Sea, half of whose inhabitants have been, at times, swept off by storm waves, it is believed that fifty-six have been introduced by man, eleven by the sea, two by the winds, and two by birds.

There is nothing more impressive in modern science than the story of what has been learned of the gradual conquest of the earth by plants.

The Color of Flowers

THE colors of flowers have been frequently studied from the chemical point of view as well as from the biological—that is, in relation to the adjustment of plants to their surroundings. But very little has heretofore been done with the physical problems involved. A recent study of the physical basis of the colors in the petals of flowers brings out the fact that the brilliant appearance of many flowers is due not to the character of the pigment in the cells of the petals, but to the presence of air spaces between the cells in the deeper layers; these inclosed air bubbles reflect from their surfaces in such manner as to give the brilliant appearance. The great variety of colors among flowers is produced by a comparatively small number of pigments. The explanation for this lies in the fact that a few pigments combined in different ways or in different proportions produce a variety of effects. Thus, a combination of two complementary pigments, one of which absorbs the light rays not absorbed by the other, will produce the effect of "black." In a similar manner gray tones and browns are produced. The shape of the epidermal or skin cells is also found to modify the effect by modifying the refraction and the reflection of light.

The Making of an Aeroplane Propeller

How One of the Most Successful French Screws is Constructed

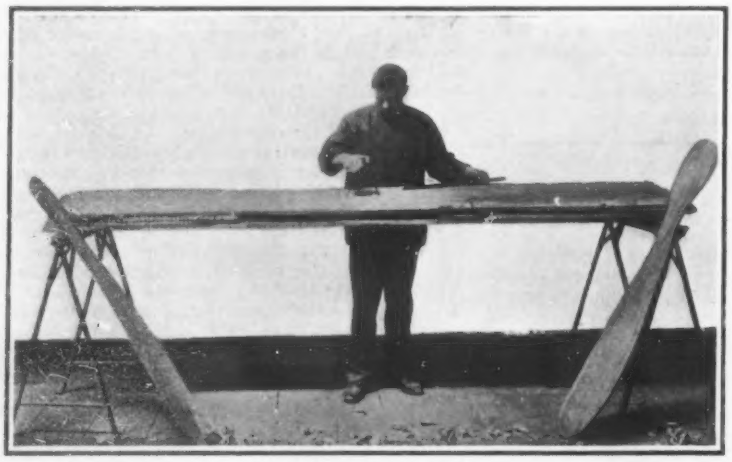
ALMOST all aeroplane propellers are made of wood, which is preferred to steel for several reasons. A steel blade is liable to snap suddenly and without warning under the influence of changes of temperature or violent shocks. A wooden blade, if sufficiently strong, is less liable to break and gives warning of impending fracture by bending and splitting.

Wooden propellers are also much lighter than steel propellers. The blade of an aerial propeller has sharp edges, but is quite thick along its median line. It is made thick, not merely to strengthen it, but because thickness offers the same aerodynamical advantage in the propeller that it presents in the sustaining planes of the aeroplane. This thickness gives sufficient strength when the material is wood, while it would make a steel propeller unnecessarily strong and excessively heavy. Wood is also much easier to work than steel.

The Chauviere propellers, which are employed in a large majority of all aeroplanes, are built up of several planks of well seasoned ash. These planks are cut to the shapes of a number of sections transverse to the axis of a propeller designed in accordance with the special conditions proposed, in regard to number of revolutions, torque, tractive effort and speed of the aeroplane. Each plank forms part of both blades of the two-bladed propeller (the usual type) and therefore a hole is cut in its middle part to receive the hub. The planks are then glued together by their faces, after having been accurately centered and oriented, so that they represent the form of the finished propeller approximately and show some of its lines accurately. The next operation consists in removing the superfluous wood between these lines and working the entire surface to the required form. This is a delicate task, requiring great skill and care, for the removal of too much material at any point would ruin the work. The surface is finished by polishing

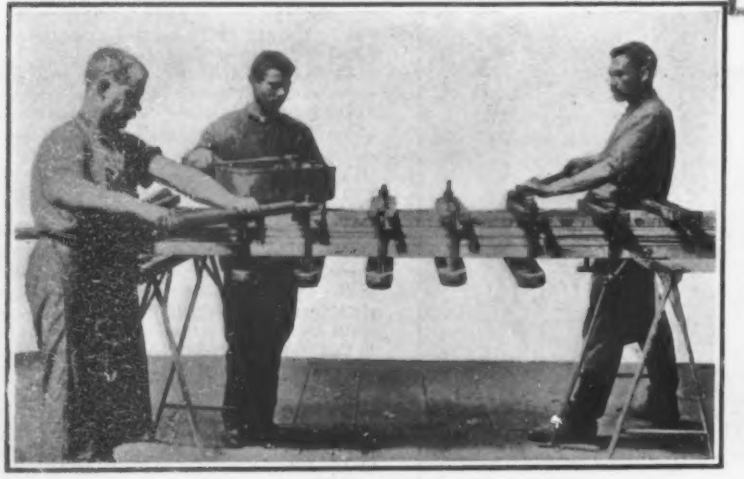
A still more delicate operation is now required in order to balance the two blades, as even a slight difference in length, weight or shape might cause dangerous vibration in a rapidly revolving propeller. The propeller is mounted on a mandrel, which is poised on very sensitive friction wheels in a specially devised machine, and the blades are carefully retouched until the propeller remains in equilibrium in every position. The propeller is then coated with a special varnish to protect it from the weather and give it a perfectly smooth surface. The finished propeller is firmly attached to the shaft by clamping its central portion between two steel disks, connected by bolts which pass through the wood.

The accompanying photographs illustrate several stages in the making of an aeroplane propeller.

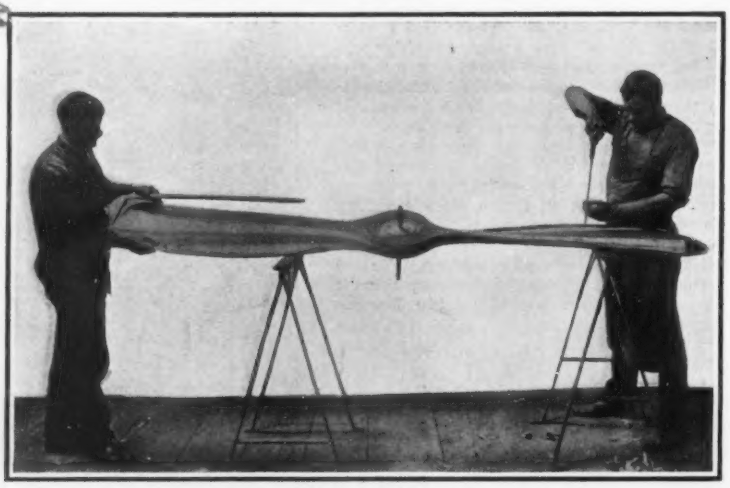


Marking center on plank.

Roughly shaping the propeller with the chisel.



Gluing the planks together.



Measuring and finishing the blades of a propeller.

THE MAKING OF AN AEROPLANE PROPELLER

Wireless Telegraphy and the Zeppelins

THE most interesting recent development in the technology of aeronautics is the application of wireless telegraphy to various types of airships. The subject is discussed in the *Fachzeitung für Flugtechnik* by the electrical engineer Richard Tann, with special reference to the rigid or Zeppelin type of dirigible.

He says: The rigidity of the Zeppelin balloons is achieved, as is well known, by a large and complicated framework of aluminium. It is only too easy for these huge masses of metal to collect from the atmosphere quantities of electricity, whose discharge not only causes very serious disturbances of the wireless system, but may be the direct cause of a catastrophe to the balloon. Indeed, the destruction of the "Z. IV." is entirely explicable as a result of such action.

Thus we may conceive that on the landing of the "Z. IV." an electric equilibrium was established by means of the branches of the tree, the resulting spark both setting fire to the gas and fusing the aluminium rods. Only fifteen seconds would be required for the complete consumption of the gas and twenty seconds for the destruction of the envelope. Measurements were made, in fact, which led to the astonishing conclusion that a potential difference existed of about 100,000 volts, which would give a tension capable of bridging a gap of 100 millimeters. (Air being ordinarily a good insulator, it is estimated that, except for great distances, a tension of 1,000 volts will bridge a gap of one millimeter.)

In view of these considerations the Zeppelin dirigible as at present constructed is obviously unfitted to carry a wireless installation, and may be said, indeed, to carry within itself the seeds of its own destruction.

On the other hand, its general efficiency has been too brilliantly demonstrated for it to be abandoned, in spite of the appalling disasters of which it has been the victim. Consequently determined efforts have been made to so modify it as to adapt it to the carrying of a wireless system and to get rid of its inherent perils.

Both these ends may be accomplished by the use of a non-conducting material, such as wood, for the construction of the framework. Wood, of course, is not an ideal material, because of its liability to deterioration from atmospheric influences. But recent experiments indicate the feasibility of its employment and its superiority to metal. In fact, a new model of the rigid dirigible has just been built at Lanz upon the plans and specifications of Prof. Schuette. He makes use of extremely light wooden tubes of ash and poplar, and his dirigible has an even greater capacity than the 15,000 cubic meters of the Zeppelins.

This improved and safer airship will soon receive a practical test of its superiority, since it is to be employed for the balloon expedition to the North Pole planned for the coming summer. Its use is expected to materially increase the prospects of the expedition for success. The wireless installation which it can safely carry is not only a safeguard to the crew in case of accident, but will permit of constant news of the results of the expedition being forwarded to the proper authorities. Thus, even if disaster and death eventually overtook the little band of intrepid explorers, they would not have died in vain like the gallant André.

In order to protect the wooden tubes as much as possible from the effects of dampness, they will be impregnated according to a certain formula. Thus Prof. Schuette hopes to avoid both disturbance of the wireless system and the dangers due to the accumulation of heavy charges of atmospheric electricity.

Sewer Water and Table Vegetables

RESEARCHES have been made by Messrs. Remlinger and Nouri, of Paris, as to the effect of sewer water upon vegetation. It was previously shown that bacteria contained in the ground could be carried to the surface of plants, and on this account the Hygiene Council of France prohibited the cultivation of certain plants on the fields of sewage disposal installations, including vegetables and fruits which grow close to the ground and are eaten in the raw state, such as water cress, lettuce, celery, onions, cucumbers, strawberries, etc. The above authors have taken up the question and wished to see whether harmful microbes are taken up within the plants or are merely carried on the surface. They show that no germs enter into the body of the plant, as Grancher already demonstrated, but microbes can be entrained along the stems and leaves during growth. However, the microbes are observed mostly in laboratory tests, and in actual practice they are hardly to be feared. Typhoid or cholera bacilli were not found on the plants. Only the very durable germs such as the tetanus bacillus are found in practice, but there is no danger from eating the plants in the case of this germ.

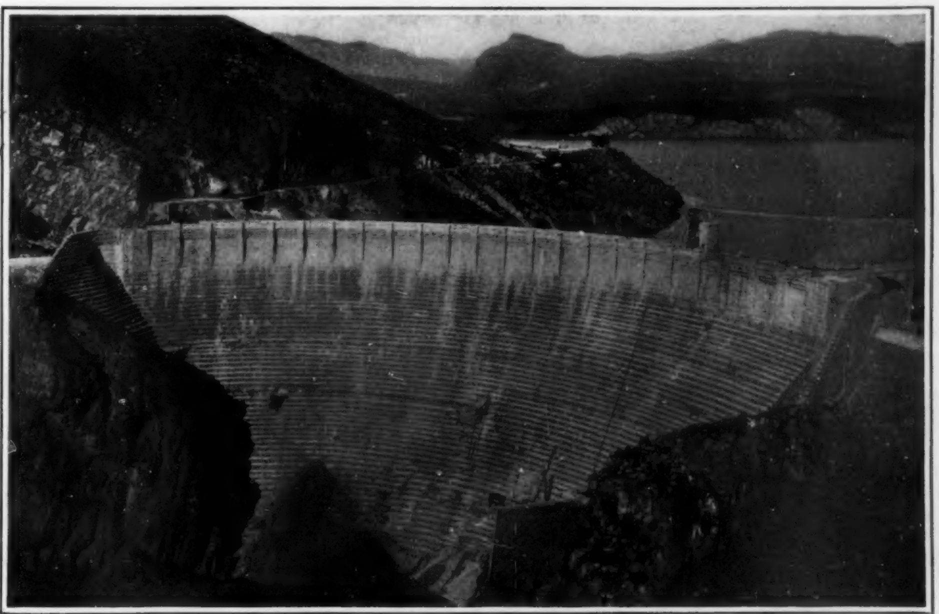
The Dedication of the Roosevelt Dam

How 240,000 Acres of Arid Land are Being Reclaimed in the Salt River Valley

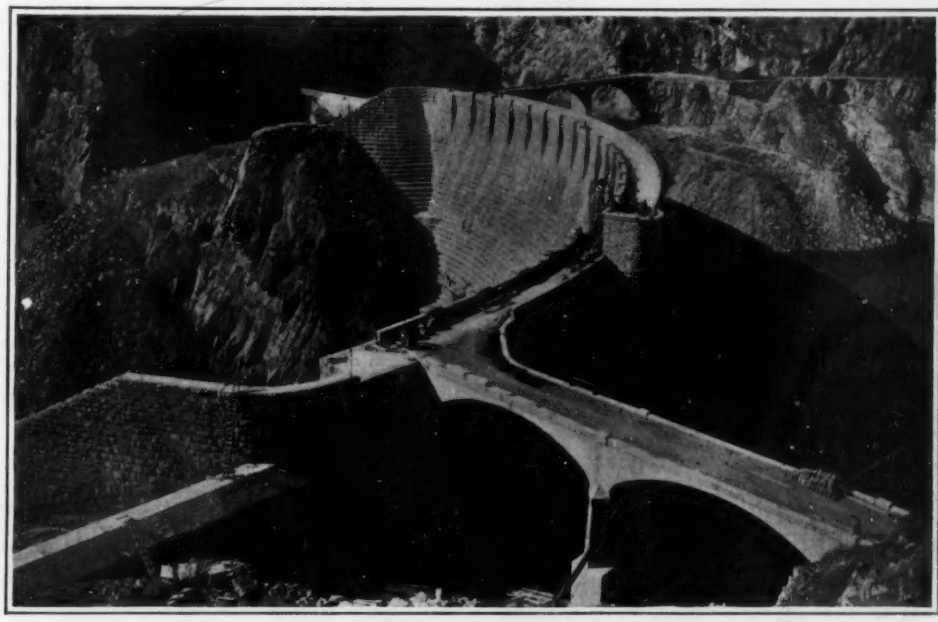
By C. J. Blanchard, Statistician United States Reclamation Service

ONE of the most notable engineering achievements of this decade, and an event of far reaching importance to Arizona, will be formally celebrated on our date of issue, Saturday, March 18th. The great Roosevelt Dam, the construction of which has been watched for several years with interest by engineers from all over the world, will be dedicated on that date in the presence of a large assemblage, notable among whom will be former President Roosevelt and family, the Governor of the Territory, members of the Legislature, engineers of the Reclamation Service, and prominent citizens of the Southwest.

It is eminently fitting that the principal orator of the occasion should be former President Roosevelt. It was due to his vigorous and virile personality that national irrigation came into being, and it was his pen which wrote into the statutes of the United States the national irrigation law. In recognition of his unfaltering interest in the cause of desert reclamation, the people named for him the imposing structure which has just been finished.



Downstream view of the Roosevelt Dam, which is arched upstream with abutments against the solid rock of the canon.

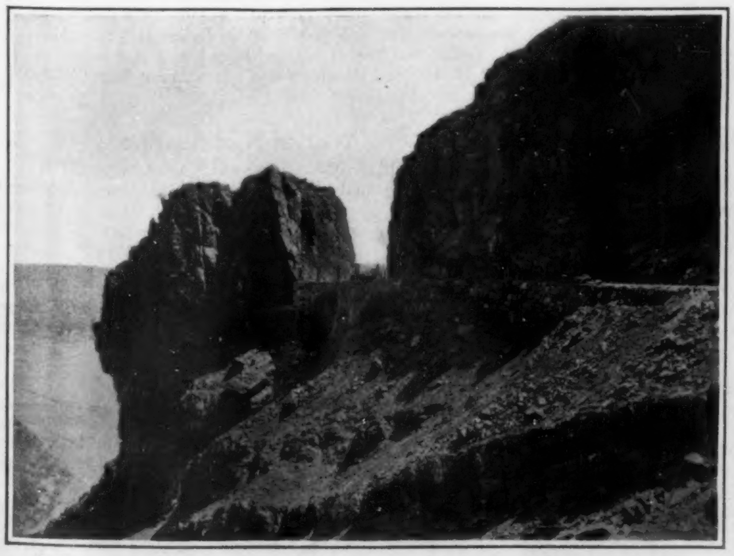


Height, 283 feet 8 inches; thickness at base, 168 feet; at crest, 20 feet; cost, $3,500,000. The dam impounds sufficient water to cover 1,284,000 acres to a depth of 1 foot.

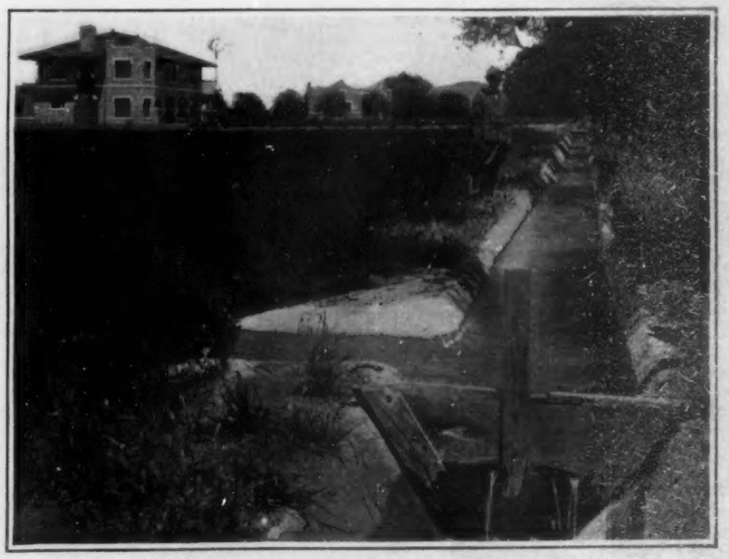
Birdseye view of Roosevelt Dam.

DESCRIPTION OF THE ROOSEVELT DAM.

The Roosevelt Dam is the most important masonry structure which the Reclamation Service has undertaken. It is also the most impressive. In the variety of the engineering problems, in the magnitude of the structure, and in the extraordinary character and number of difficulties which were surmounted in prosecuting the work, this great work ranks first among the irrigation structures on this continent. The layman and even the engineer will not readily appreciate the complexity of the problems and the diversity of obstacles which were encountered, without an understanding of the locality in which the work was carried on. The dam is located in a canyon heretofore regarded as almost inaccessible except to the nomadic Apache, who found safe refuge here for many years, or to the lonely prospector who later ventured into this remote region in search of precious minerals. The nearest railway is 62 miles away. For 20 miles the trail led through a waterless, parched and forbidding desert, where every bit of vegetation was covered with thorns anc. everything that crawled was deadly. For more than 40 miles the mountains, gashed and fissured into fantastic forms, presented an almost insuperable barrier to ingress. In the fastnesses of these barren steeps, the turbulent Salt River has carved a wonderful gorge, a miniature of the famous Grand Canyon of the Colorado. At the entrance of the gorge, between almost perpendicular cliffs of sandstone, the engineers decided upon a site for the massive structure which has just been completed. The preliminary location having been approved, work upon a road was begun to make the site accessible. This highway in itself is a work of more than ordinary interest. Nearly 40 miles of it were blasted from the solid walls of rock. In scenic beauty and artistic coloring no highway in the West compares with it. In places it skirts dark chasms, swinging around perpendicular cliffs a thousand feet high. It cost nearly $300,000 to build it. In the desert and through the mountains the government put down wells to supply the wants of the future caravans which must travel the new road. A half dozen camps were established along the route, where beds, feed and forage were provided. All this work was necessary before a stone could be laid in the dam. The main camp at the dam site called for lumber for buildings, food for the men, and power for the contractor. In the forest 30 miles away two saw mills were set up and cut several million feet of lumber. Distant springs were piped to



This wagon road, involving 40 miles of rock blasting, was built to render the dam site accessible.



Irrigating the second crop of alfalfa on a ranch in the Salt River Valley.

THE DEDICATION OF THE ROOSEVELT DAM

the reservoir at the camp. Two farms were operated and furnished meat, vegetables and forage.

Nineteen miles above the site of the big dam another dam of concrete was laid across the river, diverting a part of the stream into a large canal lined for several miles with cement and bringing the water to a point just above the Roosevelt site, where it was dropped 220 feet on turbines and generated 4,000 horse-power. This power was used by the contractor; it provided lights for the town, pumped water to the homes, and operated the machinery of the camp. Owing to the inaccessibility of the site, the government was forced to make its own cement. A large mill with a daily capacity of 500 barrels was erected and operated with power from the government plant. It turned out 340,000 barrels of first-class cement at a saving of more than $600,000 over the lowest bid offered.

The question of securing laborers for the preliminary work furnished a most perplexing problem. The work was unattractive to the white laborers. The climate in summer was oppressively hot, the site was far from habitation, and amusements and diversions were few. As one facetious engineer remarked, "White men won't stay on this job because they cannot spend their money fast enough."

Finally, in desperation and as a last resort, the engineer turned to the Indians who have long dwelt in this part of the territory. It will surprise most people to learn that they proved to be good laborers and for several years served the government faithfully and well. In the work requiring unskilled labor they were as effective as the white man and drew the same pay for their services. It is pleasing to note that the habits of industry acquired here are not being lost, as these same Indians are contracting their services to railroads and other enterprises now being developed elsewhere in the territory. In the maintenance and repair of the mountain roads, Indian foremen with gangs of their own people are in full charge.

Most of these problems were encountered and solved before actual construction of the dam began. Each was anticipated and taken up in such manner that the work proceeded without delay or friction. The contractors, Messrs. O'Rourke & Company, of Galveston, Texas, who were men of wide experience in construction, established an up-to-date plant which was carefully and intelligently placed. The work has gone forward with the minimum expenditure of power and labor, for the reason that they made use of every natural advantage the site afforded. The cement mill, rock crusher, and mixing plants were all located advantageously. Material for the cement was found in a large outcrop of fine limestone above the dam. The rock for the structure itself came from the canyon walls of sandstone in which the dam is built. This rock, which is very hard and finely grained, is distinctly stratified and dips up stream at an agle of 29 degrees, practically at right angles to the dam. The dam is of gravity section, but is also arched up stream. At its base is covers about an acre of ground. At the bottom its thickness is 168 feet, and on top it is crossed by a roadway 16 feet wide and 1,080 feet long. Its height is 280 feet to the foot of the parapet walls, which rise 3 feet 8 inches above. In plan its form is that of a quarter circle. From each of its ends abutments are extended on the tangent. About 35 feet on these tangents are the curved faces of the wing walls, and from thence there is a waste weir 200 feet long on each end at an elevation of 220 feet above datum. A spillway was cut in the solid rock around each end of the dam, the material from which went into the masonry. The spillways are crossed by three-arch reinforced bridges, each span of which is 59 feet in the clear.

Three openings are provided in the dam. At the bottom a tunnel with a cross section 108 feet and 450 feet long was driven through the canyon wall around the south end. This served a double purpose. During the period of construction it carried the river around the dam. Later it will serve as a sluicing or scouring tunnel to remove silt from in front of the dam. In this tunnel are installed six gates, one set for service and one for emergency, each with an opening of $4\frac{1}{2} \times 9$ feet.

The second opening in the dam is a riveted steel penstock 10 feet in diameter which comes out on the down stream side at an elevation of about 25 feet above the power house.

The third opening near the north end of the dam consists of three lines of five-foot cast-iron pipe passing from the up stream face through the masonry. At the junction of the masonry and the natural rock these converge into a lined tunnel 9 feet in diameter which discharges out of the face of the cliff about 100 feet below the dam.

Just below the dam is a power house 125×38 feet in which are installed six S. Morgan Smith vertical turbines, each operating a 1,000-kilowatt General Electric 2,300-volt, 25-cycle generator with Lombard governor. In addition two exciter machines and two Pelton wheels are in operation. A short distance down stream is the transformer house, where the current is transformed to 45,000 volts, thence passing to a six-wire transmission line on galvanized steel towers leading through the mountains and across the desert to Mesa and Phoenix. For more than a year Phoenix has been lighted from this plant.

Under the provisions of the Reclamation Act this power development is made a part of the project and in time will be transferred to the land owners, who will then operate it for their mutual benefit and profit. The revenue so derived should lessen materially, if it does not wholly meet, the expenses of operating the entire irrigation system.

The construction of the Roosevelt Dam has had most rigid supervision. Every rock has been washed clean before being set in place. The cement has been carefully tested at regular intervals.

On September 20th, 1906, the first stone was laid, and on February 5th, 1911, the masonry work was completed. The cost of the dam has been a little over $3,500,000.

The chief purpose of this structure is to store the flood waters of Salt River and its tributary, Tonto Creek, which join just above the dam. The storage reservoir has a capacity of 1,284,000 acre-feet, or water enough to cover that many acres a foot deep. The water shed supplying this reservoir has an area of 5,800 square miles, or an area almost equal to that of Connecticut and Rhode Island.

As the reservoir is located sixty miles from the land to be irrigated, the river will be used as a carrying canal for that distance, and the water will then be turned into artificial canals by a diversion dam which has been built at Granite Reef. This is a rubble concrete weir 38 feet high and 1,100 feet long, and diverts water into two large canals, which in turn supply the entire irrigation system of the Salt River Valley. The canals of the valley have a total length of 119 miles, and the principal laterals 208 miles. They are designed to supply an area of 240,000 acres, of which 190,000 acres will be covered by gravity and 50,000 by pumping.

SALT RIVER VALLEY.

More than ordinary interest attaches to this region for the reason that irrigation was practised here long before the first word of our history was written. The valley has been inhabited by three races, two of which have vanished. Of the first, or prehistoric race, very little is known. Evidences abound throughout the valley that they cultivated extensive areas and excavated many miles of canals. Some of these were constructed with much difficulty and labor, as the excavations were in rock and the work was performed with stone implements. The engineering skill of this people was remarkable, for many of these canals are utilized to-day by the modern systems.

Salt River Valley includes several million acres of land with a soil of superior fertility and a climate warm and arid. This produces a region of remarkable healthfulness and adapted to the production of crops ranging from those of the semi-tropic to those of the temperate zones. Its average rainfall is only five inches, and its average temperature is 69 degrees. Without irrigation no crops can be grown, but with it crops grow throughout the year.

Agriculture here has become a science, and the duties of the farmer are regulated very much as those of the business man. Where crops are intelligently diversified there is little of the back-breaking, heart-discouraging work of the old-time farmer. Crops ripen and are harvested at different intervals, giving the farmer ample time without crowding. With assured harvests and the absence of rain the farmer can apportion his time with some degree of accuracy. The valley enjoys excellent roads, country telephones, rural delivery, and trolley lines are being extended from the cities and towns. Its railroad facilities are good and are being extended to meet the growth of the community. Its educational institutions are first class. In various sections the farmers have organized co-operative associations to market their crops.

As a whole, the citizens of the valley are made up of a strong, intelligent class who have come from all parts of the Union. They are cosmopolitan and progressive. In points of civic pride and social ideals the community ranks high. Poverty is practically unknown.

With the completion of the irrigation system which is being constructed by the federal government, we may safely predict for this valley an era of progress and substantial growth which will place it in the forefront of the most up-to-date agricultural districts in the world.

Correspondence

Politics and Battleship Costs

To the Editor of the SCIENTIFIC AMERICAN:

The Sixty-first Congress, just adjourned, passed the naval appropriation bill with the eight-hour law now in force in our navy yards tacked on to cover private shipyards also, and provided that the battleship "New York" of the 1910 programme be built in a government navy yard. The Democrats, who all along have opposed heavy expenditures on naval increase, and who have been crying "economy," were responsible for the above measure. In other words, their "economy" was to waste $3,410,000.

It is true that building in government yards stimulated the private yard construction and raised it to its present high standard, that of the cheapest and quickest built battleships in the world; but as Secretary Meyer has pointed out, the cost to the government of this stimulus offsets the value of the same, and need only be instigated when the private contractors seem to be lagging. Therefore, it is not necessary to have one of our two yearly battleships built in a navy yard, as the opponents of private-built ships would wish. The government cannot build as cheaply as the private yards, even though the latter expect to show a profit, while the navy yards can go the limit. With our merchant marine a negligible quantity, the private yards ought to be encouraged. They are starving for work, and it is enough for them that they keep their enormous plants working.

The government-built "Connecticut" cost $200,000 more than the private-built "Louisiana," and it is estimated that the "Vestal" and "Prometheus" could each have been constructed for $200,000 less if they had been given to the shipyards. This misdirected idea of patriotism cost the government $2,454,000 in the case of the "Florida," her total cost being $6,400,000, against that of her sister ship "Utah," private-built, of $3,946,000. Moreover, the "Utah" goes into commission in two months, and it is doubtful if the "Florida" will be ready before next November. Then Congress had to appropriate $200,000 for the Pacific coast collier above her original $1,000,000. If the "New York" had been given to private contractors, $1,790,000 would have been saved, which represents the difference between her cost and that of the private-built "Texas." All this totals up to $4,444,000, a clear waste caused by local politics and benefits being placed before economy for the entire country. The only satisfaction to be gained from this is the fact that as the Brooklyn Navy Yard is the only one capable of building battleships, and as only one can be built there at a time, the worst that can happen is a government-built ship every other year, or one in every four constructed. This is not necessary to keep the private yards up; one in every eight would be sufficient. The navy yards can keep their forces busy between times on collier construction and overhaul and repair of ships.

But this is not all. In addition to local politics the labor unions got busy in Washington, with a result that the eight-hour law went through. As if the private yards had not enough to contend with! Of course, up went the price of battleships, and to this law we owe the amount of $1,220,000 more on the "Texas" than was necessary and $400,000 on each of the two colliers. This waste will not come on alternate years, but *every* year, and will increase as the battleships increase in size, as the waste represents twenty-one per cent of the total cost. To this total of $1,620,000 may be added the $4,444,000 extra resulting from navy yard construction, and you have a total of $6,064,000 for the 1910 and 1911 programmes alone! This means that exclusive of armor and armament, *another battleship could be built* every other year *in addition to the two* regularly authorized, if the last naval bill had not gone through with the navy yard construction and eight-hour law provision. And yet how a certain group in Congress would howl if an extra ship were to be provided for on alternate years! It is a sad commentary on our ideas of economy and patriotism when such legislation as this is enacted by our dignified Congress.

HAROLD M. KENNARD.

Brooklyn, N. Y.

"Aviation," "Volation," or "Flying"

To the Editor of the SCIENTIFIC AMERICAN:

In your esteemed number dated February 25th a certain Wells Drury, of Berkeley, Cal., proposes the words "Volator" and "Volation" for the generally introduced words "Aviator" and "Aviation."

Your reply was that, by accepting the word "Volation," there would be a confusion with the word "Volition," and therefore meeting with your disapproval.

I beg to say that confusion is absolutely impossible, for the simple reason that the word "Volation" is derived from volare, i. e., to fly, and the word "Volition" is derived from the word volere, i. e., to will; therefore these words are of radically two different meanings! Neither in writing nor in speaking a misunderstanding can occur.

By the way, how is it with the words complement and compliment? They are always used in their particular meaning without causing an equivocal. There are a number of other similar words used in our language.

But—returning to the neck-breaking sport—if the people in Berkeley dislike the "Aviator" and the "Aviation" and are so very fond of changing them just for the sake of wishing to be served with a new expression, I beg to inform them of two good American words for their use: "The Flyer" and "the Flying." These words do not only *fully replace* the strangers "aviator" or "volator" and "aviation" or "volation," but are *comprehensible* for anyone—whether linguist or not.

Grantwood, N. J. ADOLF TH. SCHWAB.

Aviation Nomenclature

To the Editor of the SCIENTIFIC AMERICAN:

I am surprised at your reason for not concurring with Mr. Drury in his suggested use of "volator," as a synonym for aviator, because, as you say, of the word "volition," which comes from the Latin "volo," to will. I would suggest that you look up "volar," which in Spanish means *to fly*. You may find Mr. Drury's claims just. This is as far as I dare *air* my knowledge in the matter.

GRIDLEY ADAMS.

Dayton, Ohio.

The Poured House

IN his article on the one-piece house (see page 276), Mr. Perry expresses doubt as to the practicability of Thomas A. Edison's plan of making monolithic houses. A copy of this criticism was sent to Mr. Edison for his perusal. He responds as follows:

"Nothing pleases me more than to have engineers put themselves on record as to the certainty of the failure of experiments in which I am engaged. The iron molds of my house are finished, with the exception of the roof, and the experiment will be carried to a finish.

"THOMAS A. EDISON.

"Orange, N. J., March 2nd, 1911."

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The Problem of Waterproofing

The Properly Built Concrete House is Dampproof

By Ralph C. Davison, Consulting Engineer

PROBABLY one of the greatest obstacles to the rapid spread of concrete construction to-day, especially for private dwellings, lies in the idea which has gained a hold on the general public, that all concrete structures are damp. The task of convincing them that this is not so has been made harder by the erection of a number of so-called concrete structures, which are without question more than damp. Many structures of this kind have been erected by men who knew little or nothing about the material, and they have done more to retard the advance of concrete construction than one can tell. Dealers in rival building materials have taken advantage of these examples and with them have tried to show prospective builders how impossible it is to obtain a dampproof concrete building. Concrete if made rich is waterproof enough for all practical purposes, but from a commercial standpoint this is not practical for the reason that so much cement would have to be used that concrete would not be economical. Therefore the question of waterproofing, even good commercial concrete, is an important one.

There is a large and growing demand for good waterproofing materials. Probably nothing will show this better than the statement that some six to ten years ago there were about two or three firms, at the most, who were making materials with which to waterproof cement. To-day there are probably upward of fifty at least and a new one coming into existence every month or two. Notwithstanding the number of the above companies they all seem to be making enough to exist on, which goes to show that the field for a good concrete waterproofing is practically unlimited. The writer will not attempt to go into the details of the merits or demerits of any of the above waterproofing materials, as this article is not intended to be a treatise on waterproofing, but is merely intended to impress upon the prospective builder the importance of waterproofing concrete and to give a general idea of how the waterproofing question can be attended to so as to secure a perfectly dampproof concrete house.

The waterproofing of the foundation and the parts of the cellar walls which are below grade will first be considered.

It is surprising, especially in the construction of small houses, how little attention has been given to below grade waterproofing by architects and builders. It is of the utmost importance, not only from a commercial point, but for the ultimate efficiency of the work, that the structure be designed from the start with a due regard to waterproofing. The above fact cannot be too strongly emphasized, for it will prove both a loss of time and money to build without in some way caring for the waterproofing, for the reason that when a building that is once up starts to leak, it is, in most cases, a costly procedure to make it water tight. Indeed, in many cases, it is almost impossible to do so without sacrificing space or tearing away a good part of the finished work in order to apply the necessary waterproofing materials. Local conditions largely govern the methods to be used in below grade work. If there is water pressure to contend with, great care must be taken. Probably the best and most successful method to use in this class of work is shown in Fig. 1. The materials to use should be either some form of asphaltic compound or coal tar pitch, in connection with from one to six ply of waterproofing felt or fabric. The number of layers of felt to be used is dependent, largely, upon the water pressure which has to be resisted.

First of all, where space will permit, the excavation should be made large enough to provide sufficient room around the outside of the foundation walls to allow ample space for the proper application and handling of the materials. Then after the footing is laid a course of waterproofing should be applied on the top of it, covering it from edge to edge, as shown at *a* in the small detail *A* in Fig. 1.

On top of this should be erected the foundation wall, allowing the waterproofing course to project on each side of it, as shown at *b b*. When the foundation wall has been completed, the portion of the waterproofing which projects on the outer side of the footings should be turned up against the bottom of the foundation wall and securely cemented to it with either asphalt or coal tar pitch, as shown at *e* in the small detail *B* in Fig. 1.

After this has been done, the next step is to apply a waterproofing course to the outside of the foundation wall from the ground or grade line down to the top of the footing, as shown in the small detail *C* at *d* in Fig. 1, care being taken to see that it laps over and is well cemented to the part *c* of the waterproofing course which has just been turned up against the bottom of the foundation wall.

The waterproofing of the cellar floor is next to be cared for. The rough concrete foundation for this should be brought up flush, or on a level, with the top of the footing and should be made fairly smooth. To this surface should then be applied the waterproofing course for the cellar floor; care must, however, be taken to see that it laps well over the waterproofing layer which is already in place on the top of the inner side of the footing, as shown at *e* in the small detail *C* in Fig. 1.

After this waterproofing course is in place the necessary thickness of concrete to resist the existing water pressure should be laid over it. By following the method thus described one will have a continuous waterproofing course throughout the entire foundation which, if properly laid, will result in the procuring of an absolutely dry cellar, regardless of how wet or damp the ground around the house may be.

If space does not permit of placing the waterproofing course on the outside of the foundation walls, a curtain wall, as it is called, made of one thickness of brick or lean concrete, may be set up. Then on the inner side of this wall, as shown in Fig. 2, the waterproofing should be applied.

The foundation walls proper can then be set up or cast directly against the waterproofing course. Thus a continuous course of waterproofing is obtained throughout the entire foundation, as in the first method, but it entails, as explained, the additional cost of erecting a curtain wall. It is only necessary to use the above methods where there is more or less water pressure to contend with. If one only has dampness to provide against, one or more good heavy coats of asphalt or tar applied hot on the exterior sides of the foundation walls will prove efficient. In cases where there is but slight dampness to contend with, one of the many preparations of asphalt in semi-liquid or liquid form, which can be applied cold with a brush, will be sufficient to prevent the dampness from striking through. This is a cheap method and has proved most effective in many cases.

When filling in the ground around a foundation treated in the above manner, care must be taken that no sharp stones, glass or tin cans come in contact with the surface, for if they do they may cut or abrade the dampproof coating. In many instances a thin layer of cement is plastered over the dampproofing course in order to protect it from any damage that might occur from the above cause.

Other methods of waterproofing concrete for below-grade work are used; they consist chiefly of what is technically known as the integral method, by which is meant the incorporation into the cement of some foreign substance, which is much finer than the particles of cement used. The fundamental principle of this system is to mechanically fill the minute voids, which not only theoretically but practically do exist, between the grains of sand and the particles of cement, and to thus render the mixture denser and less pervious to dampness. There are many substances on the market, bearing various trade names, which are advocated by their makers to be used for the above purpose. Some of these are in liquid form, others in paste form, and again many are in the form of a finely ground or air floated powder.

One of the most common materials used for this purpose, and with considerable success, is hydrated lime. Five per cent by weight of this material added to the cement used will give excellent results, without interfering in any way with the strength of the concrete. There is no question that good results have been and can be obtained by the incorporation into the mass of such materials as mentioned above. The only objection which the writer has to this method of waterproofing concrete is that in case of settlement in the foundation, cracks will develop. If one could be assured that there will be no settling, then it would be safe to use the integral method of waterproofing. But where there is any doubt it is best to use a regular waterproofing course, as explained at first, in which there is more or less flexibility, allowing it to bridge over any small cracks which may develop owing to settlement, so that the structure will still remain intact and be efficient.

The dampproofing of the exposed walls will be considered next. There are various methods used, such as dampproof compounds, which are applied on the inner side of the walls—so-called colorless liquid solutions which are applied to the outside face of the walls and colored waterproofing paints which possess the advantage of decorating and waterproofing at the same time. If a dampproofing compound is used it should consist of a base of pure asphalt thinned down with some light oil, such as benzine, to a suitable consistency for spreading with a brush. It should also possess the properties of remaining "tacky." Some dampproof compounds on the market dry out very quickly and lose their "tackiness." This is a poor feature, and one which should be guarded against, as they then lose their flexibility and also their efficiency for bonding well with the plaster. These compounds are all black in color, and are only applied on the inner surfaces of the exposed walls in order to prevent the penetration of dampness. They are largely used as a substitute for wood lath, metal lath or hollow furring blocks, or they may be used in connection with any of the above in order to insure an absolutely dry air space. If used alone, it is well to specify two coats over which the plaster can be directly applied, thus doing away with the air space and the additional expense of furring.

The above method of dampproofing is largely used even on some of the highest class apartment houses and loft buildings, but it does not keep the driving rain from entering into the outer surfaces of the porous brick or concrete walls. What it does do is to form a waterproof film between the inner side of the walls and the plaster and thus prevents the dampness from soaking into the plaster as it otherwise would do. Many object to this method of dampproofing for the reason that it does not protect the outer surface of the wall, as stated above. A concrete wall saturated with rain not only takes a long time to dry out, but its appearance for two or three days after a storm is anything but pleasing, inasmuch as it dries out unevenly, which causes it to present a blotchy and unsightly appearance. Therefore many architects preferably treat the outside of the wall with a good waterproof paint and in many cases, where they have doubts as to the waterproofing qualities of the outside treatment, they make doubly sure, and treat the inside of the walls as well with a dampproof compound as explained above.

A word here in regard to the proper paint to use for coating concrete may not be amiss. If linseed oil paint is to be used great care should be taken to see that the concrete or cement which is to be painted is at least one year old. This will give it ample time to thoroughly cure and dry out. Then before painting, the surface should be well washed with a weak solution of muriatic acid followed by a thoroughly good washing with clean water. This will not only clean the surface, but will help to neutralize the alkali in the cement, which if left there will saponify the oil and cause the paint to crack and peel off. Care must be taken to see that the wall is entirely dry before painting is started if good results are desired.

(Continued on page 290.)

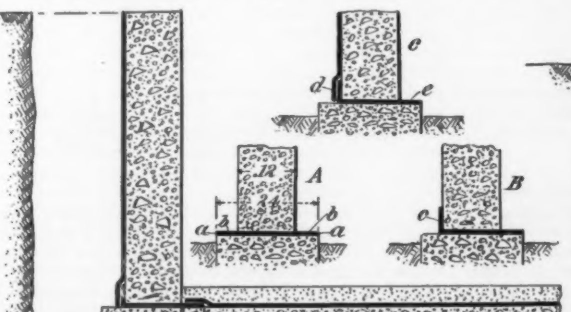


Fig. 1.—Practical methods of applying below-grade waterproofing.

Fig. 2.—Below-grade waterproofing in limited quarters.

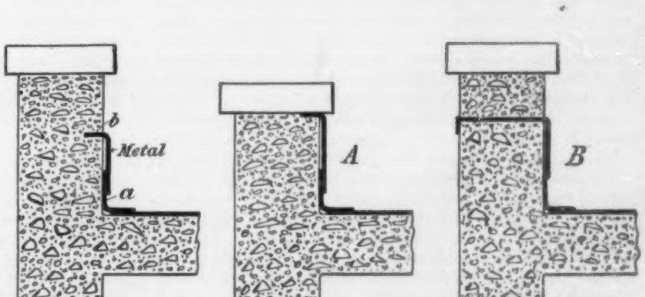


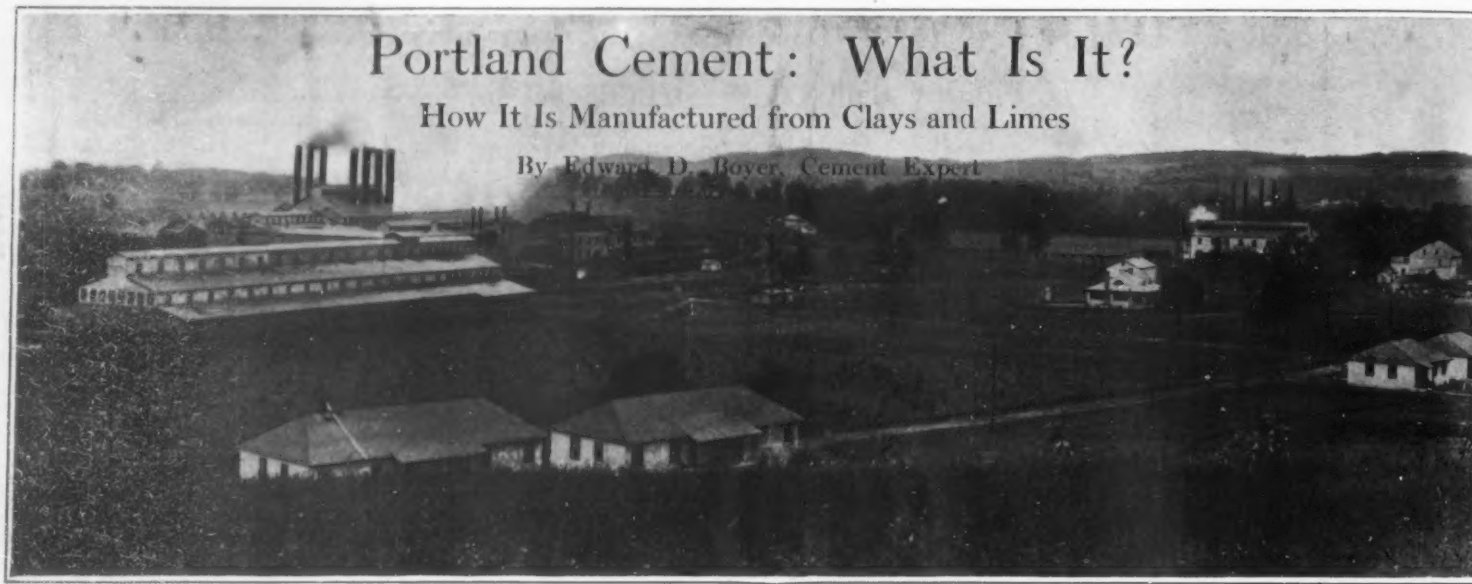
Fig. 3.—Various methods of applying flashings and counter flashings.

THE PROBLEM OF WATERPROOFING

Portland Cement: What Is It?

How It Is Manufactured from Clays and Limes

By Edward D. Boyer, Cement Expert



SO prodigious has been the growth of the Portland cement industry, so marvelous its development, that the public in its breathless endeavor to keep track of ever-increasing uses of this wonderful material has scarce had the time to ask what the stuff itself is. And yet, despite the fact that Portland cement has become absolutely indispensable not only to the engineer and the builder, but on the farm and about the house as well, many a man, otherwise well informed, would be somewhat embarrassed for an answer, if asked point blank: "What is cement and where does it come from?"

So much has been said of Portland cement that one is apt to forget that there are other cements such as Rosendale, a slow setting cement, and Puzzolan, a product of iron slag. But the manufacture of these cements is insignificant compared with that of Portland cement. The brickmaker of Leeds who discovered that a wonderful product could be obtained by mixing the English chalk or lime with clays from the bed of the River Thames named the product Portland cement from its resemblance to a well-known and popular building stone in England, which stone was quarried on the island of Portland and was considered the hardest of the known building stones.

Portland cement was at first imported into the United States from Germany. Then the discovery was made that this country also contained materials from which the product could be manufactured. When, finally, we became interested in the product, with characteristic energy and enterprise we forced our way rapidly to the front, and with improved methods and appliances forged ahead until to-day American Portland cements are the acknowledged superiors of any in the world, not only in quality of product and improved methods, but in the quantity also.

In one region alone, the Lehigh Valley district, in the State of Pennsylvania, more Portland cement is manufactured than in the whole of Germany and England combined.

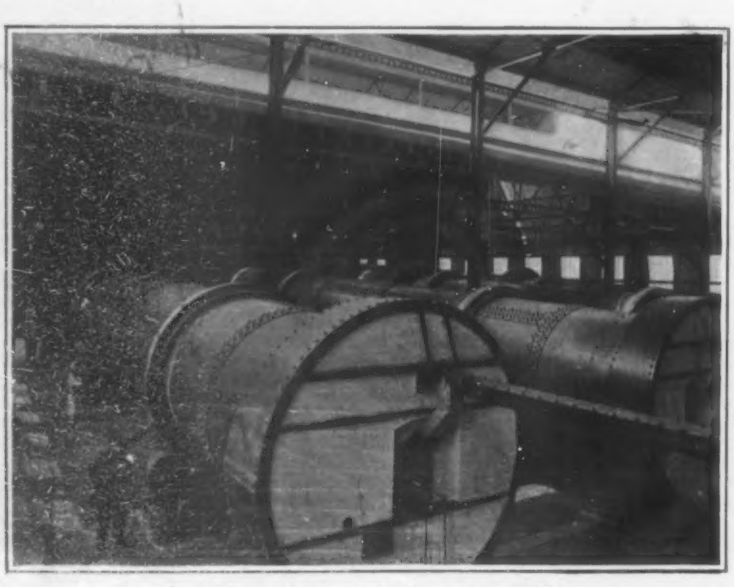
Within a decade (1899 to 1909) the cement industry of the United States has increased twelve hundred per cent! And this growth has been due to the fact that the American public has been quick to grasp the possibilities of this adaptable material. Here is an ideal building material, a stone that does not have to be hewn from solid rock, but merely mixed up like a paste with broken stone and sand and then poured in place! Could one ask for anything simpler or more opportune at a time when the scarcity of lumber is becoming serious? No wonder the cement industries have grown.

Portland cement is a chemical composition, a trisilicate of lime and alumina. It can be manufactured wherever these materials can be found. In the Lehigh Valley, Pennsylvania, district, where for a long time 75 per cent of all the Portland cement in the United States was manufactured and where to-day about 50 per cent of it all is still manufactured, there are extensive natural deposits of what is known as cement rock, which, with the addition of a small percentage of lime, contains the ingredients before mentioned. This raw material is quarried and in various ways conveyed to the plants, where with a system of crushers and pulverizing machines it is crushed and reduced to a very fine powder. The process is continually controlled by chemical analysis, a corps of expert chemists being in charge of this work night and day. The resulting pulverized raw material of the proper chemical composition is then fed to rotary kilns, where it is burned to what is known as "cement clinker."

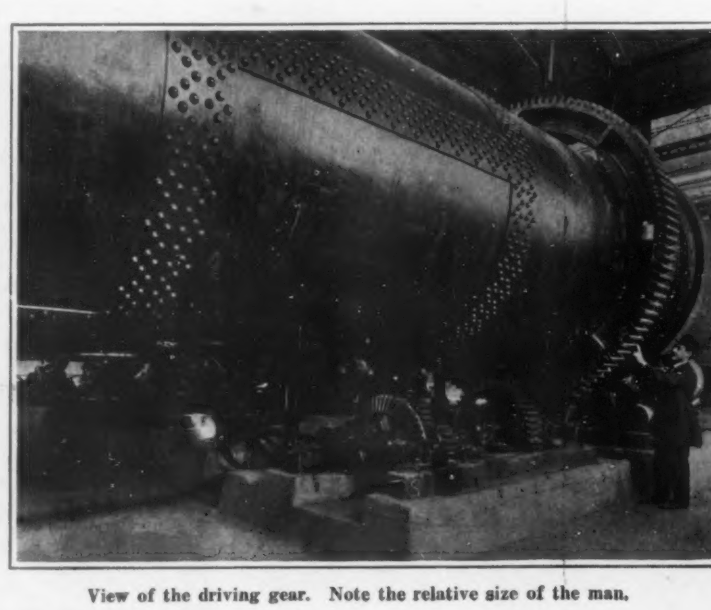
In the early days in Germany and England, as well as in the United States, Portland cement was burned in what were known as dome kilns, the mixture of limestone and shale in various shapes being set in these kilns with alternate layers of coal or coke, the product of a kiln seldom exceeding 100 barrels a day. In the year 1890 one of the largest Portland cement companies began experimenting with and rapidly developing what is now known as the "rotary kiln." This, to-day, is being used for calcining Portland cement in every mill in the United States and is gradually though surely succeeding the old dome kiln in Germany and England. These rotary kilns produce from 500 to 3,000 barrels of Portland cement per day according to their size and they alone have been largely instrumental in cheapening the cost of the manufacture to such an extent as to make Portland cement a cheap and economical building material.

Briefly described, a rotary kiln is a steel cylinder, six to twelve feet in diameter and from 60 to 250 feet in length, and is continuous in operation, the raw material being fed in at one end, and the finished product being discharged at the other end, toward which it travels by reason of the inclined position of the kiln and its rotary motion. During the passage of this raw material from one end of the kiln to the other, perfect calcination is obtained by the injection of pulverized coal into the kiln by means of an air blast, the coal being ignited as it enters the kiln. The resultant clinker is then cooled and pulverized into a very fine powder and becomes the Portland cement of commerce. This process of grinding the raw material and later the clinker has been the serious problem of cement manufacture, as therein also lay an opportunity of lowering the cost of production. The reduction of any material to a fine powder by machinery involves great cost, and particularly was this the case with the materials entering into the manufacture of cement. It was early determined that the finer the raw materials were ground, the more intimate the mixture of the component parts; and while in the early stages of the industry, French burr stones were used for this purpose, to-day every mill is equipped with some form of heavy iron mill, which equipment not only increases the production per hour but also materially assists in reducing the cost.

Portland cement is seldom used neat or unmixed with sand and crushed stone or gravel. Mixed in this manner it forms what is known as concrete. This mixture of sand, stone and Portland cement with water becomes plastic when first mixed, and owing to this takes the form or shape of anything in which it is placed, whether wooden or iron forms, or sand or plaster molds, and within twenty-four hours becomes hard enough to have these forms removed, and within a week as hard as most of the natural stones. This material becomes harder as the years roll by, never deteriorates, never requires repairs, is waterproof, fireproof and in fact is everlasting. Its uses grow every year, from the early stages when it was only considered by the engineer for building foundations for building and machinery, until to-day it is the prime factor in every large building operation, and is familiar to both architect and engineer as a material that helps to solve problems hitherto considered incapable of solution. Think of just a few of the large engineering propositions of the day like the Panama Canal, the tunneling of the rivers, the subways, the large water storage and supply systems, the great irrigation projects of the West, and know that without Portland cement they would have been well nigh impossible. The variety of uses to which this wonderful material can be put can best be described in the statement that there is no engineering project too large nor any household use too small for the adaptability of concrete.



A battery of rotary kilns in a cement mill.



View of the driving gear. Note the relative size of the man.

MACHINERY OF A PORTLAND CEMENT FACTORY

Saving Trees by the Use of Cement

How the Tree Surgeon Stays Decay with Cement Fillings

By M. L. Davey

IN our minds disease and suffering are so closely associated that we ordinarily regard the allaying of pain as the fundamental function of medicine and surgery. We are apt sometimes to overlook the economical gain to the community which the maintenance of health among its members implies. The economic factor is of course quite prominently displayed in veterinary practice, though here also there is pain to be alleviated. When we come to the vegetable kingdom the purely "benevolent" motive for medication is practically absent. This perhaps is the reason why we hardly class plant surgery in our minds in the same category as the treatment of human and animal ailments. But while there is thus a pronounced difference in the two fields, in most other respects they are very similar.

The plant, like the animal, is a living thing, subject to the attacks of enemies in life and ultimately to death. Like the stricken animal, also, the diseased plant is ready to receive at the hands of man beneficent medical or surgical treatment. And in plant surgery, as in the practice of the art on the human being, a species of asepsis is essential for success.

In the science of plant medication quite an important rôle is played by cement. This material has, in the practice of tree surgery, a definite, well defined purpose, and certain fixed methods of application. This does not mean that all trees should be treated alike. This is obviously impossible. However, there are certain principles which must be incorporated into each cavity, and these principles are the same for each case.

In order to understand the use of cement in trees we must understand the purpose of the operation and something of the life processes of the tree. The inside of a tree is practically dormant, except the few layers of woody fibers just under the bark. The sap ascends in these *outer* woody fibers, and enters the leaf where it undergoes the chemical change which produces the "tree-food." This tree-food descends just underneath the bark, building as it goes. It continues to descend and build until it reaches the tiniest roots. Thus we see a real circulation in the tree. The central tissues serve no purpose save that of physical support. If any other substance can take its place and accomplish the same result, the tree will continue to live and thrive indefinitely, provided the new center of the tree is sealed tight to the adjoining tissues and remains so. The real life of a tree is represented by the bark, the cambium layer just behind it, two, three or four inches of sap-wood just behind the cambium, the leaves, and the roots. If these parts are vigorous and normal, it makes little or no difference whether the center is wood or stone.

The bark is a protection for the tree. Where the bark remains intact, the woody fibers of the inside are preserved for generations and for centuries, unless some outside agency kills the tree. Destroy any part of the bark by any means whatsoever, and when the protection is gone the wood decays. Once decay secures a start, its progress is rapid. It continues until checked by artificial measures or until the tree becomes so weak that it is blown over in a wind-storm. The tree may appear to be in a perfectly healthy condition even with the entire inside rotted away, simply because the vital parts (three or four inches on the outside) are the last to be destroyed. Decay attacks and disintegrates the dormant tissues first, and gradually works outward.

Cement in trees fulfills the three-fold purpose of stopping decay, serving as a structural support, and providing a surface over which the bark may heal.

Is cement work in trees a success? In other words, is Tree Surgery a real or fancied good? Does it save the trees? That depends on the vitality of the tree, and the ability of the man who undertakes the work. A man may be so nearly exhausted and so low in vitality that all the doctors in the land could not save him. A tree may be the same. If it is weak and far spent the chances are against it. If it is vigorous and healthy, the chances are all in its favor *if the man who operates knows how*. The only real test of a tree's vitality is the appearance and density of the foliage. A rich-green, abundant foliage indicates health, and *vice versa*. And still almost the entire inside may have rotted away!

Tree Surgery, or that part of it pertaining to the filling of cavities, is aptly comparable with dentistry. The three fundamental principles of each are the same. The dentist must remove all decay and prevent more, prepare the cavity so that the filling will stay permanently in place, and exclude all foreign substances. The tree surgeon must do the same things, although the means to that end may differ somewhat.

To remove the decay from a cavity requires chisels and gouges of various lengths and sizes. The smaller cavities are not exceedingly difficult, although they require the same exacting care. The larger a cavity becomes the harder the task of removing the decay. It must be followed in the cracks and crevices and away up and down through limbs and trunk as far as it goes. It is sometimes burned out, although this measure is very dangerous unless applied by a man who thoroughly understands its use. When the decay is removed, it is wise to apply corrosive sublimate or a similar solution to destroy any remaining fungi. The walls of the cavity must then be thoroughly waterproofed to protect the wood. The waterproofing material must be durable, penetrating and adhesive. This is the first step and is very similar to the first principle applied by the dentist.

Perhaps the most difficult and trying part is in preparing the cavity so that the filling will stay permanently in place. This requires more than a knowledge of cement and its use. It requires more than a scientific knowledge of trees. It requires both these and more. The operator absolutely must know the practical methods of tree surgery, and have acquired almost instinctive skill with his hands by long practice. Cement improperly put into a tree is far worse than none. The law does not permit untrained men to practise upon the human body or even that small part of it called the teeth. Why should untrained men operate on trees which are just as much alive as human beings?

The cavity must be thoroughly braced if it has any size. No man can set down in words the manner in which this should be done, because it depends absolutely upon the size, shape and general condition of the cavity and the strength of the woody shell. The operator must determine the weakest side or point and brace it with great care. He must know what stress must be borne by the tree and insert steel ribs or truss rods to reinforce the trunk. All this must be done with a full appreciation of the fact that there will be *some* sway to the tree. Oftentimes it is necessary to put the cement in in sections, leaving natural joints which will permit the swaying without damage to the cement fillings. If the operator does not understand the swaying of the tree and guard against it, or does not where necessary build his cement in sections, all his carefully laid plans up to this point will go for naught. Unless he can keep his filling permanently in place, just as in dentistry, his work is a complete failure.

The exclusion of foreign substances, especially water, is the ultra-important task of the tree surgeon, just as it is with the dentist. If the water seeps in behind the cement filling, it is only a question of time until the condition of the tree is worse than formerly. *No cement work is a success which does not exclude the moisture.* The skilled tree surgeon prepares a "water shed" at the edge of the cavity, beyond which the moisture cannot penetrate. To make assurance doubly sure he applies to this water shed all around the edge of the opening an adhesive waterproofing material. At times it is necessary to go farther than this and cover the entire opening with a metalic shield, non-corrosive, which is nailed very tight on the top and along the sides especially. Waterproofing material is then applied on the outside.

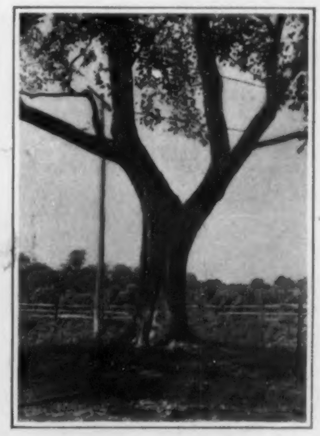
All of this must be done with the ultimate purpose of allowing the bark to heal over the filling. Therefore the filling must be *under the edge* of the bark at every point, and the contour of the tree must be restored, so that when the bark does heal over and seal the filling permanently, there will be no evidence of the old yawning cavity save the unobtrusive scar. As surely as there is health and vigor in a tree the bark will begin to roll out and over the filling. Nature responds wonderfully to proper treatment.

A tree is a living creature! This is the foundation fact of tree surgery. It ministers to the human family in comfort, health, beauty and pleasure. It is past valuation. It makes possible the solemn stillness of the forest. It holds in check the waters that go to form the rivers and insures their continuity. It robes the hills in green and hides their gaunt and lifeless forms. It gives grace and beauty and verdant loveliness to the valleys. It shades the urban highways where masses of mankind pass to and fro. It shelters and makes beautiful the public parks, the breathing places of the people. Its contribution to the food of man is of untold measure.

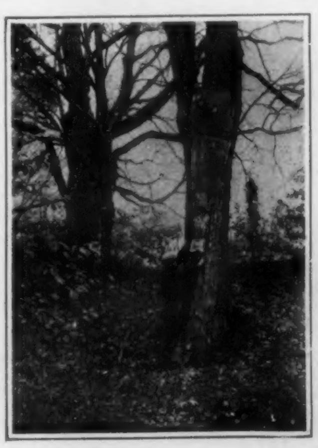
A tree is a fitting companion to man. It is quite proper that the highest development of the vegetable kingdom should contribute so largely to the well-being of man. Man should in turn give it reasonable care and protection so that its period of ministration may be a maximum. Because a tree is a living organism it is subject to decay and premature death. Tree Surgery is the concrete expression of man's desire to protect the physical well-being of the trees and preserve them for his own pleasure and profit, and for that of the generations to come. Real Tree Surgery saves trees. It is well. Thus we have another step in the advancement of man.

The original contour of the tree must be restored.

Note how the new bark is growing over the cement.

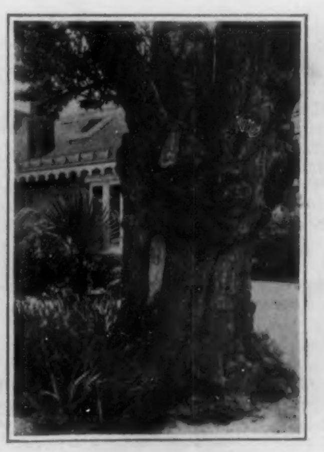


The filling in sections to protect it against sway.



Work of a poor surgeon. Filling cracked off in five years.

Amateur work. Growing bark is sure to crack the filling.



The cavity was large enough for a man to work inside.

SAVING TREES BY THE USE OF CEMENT

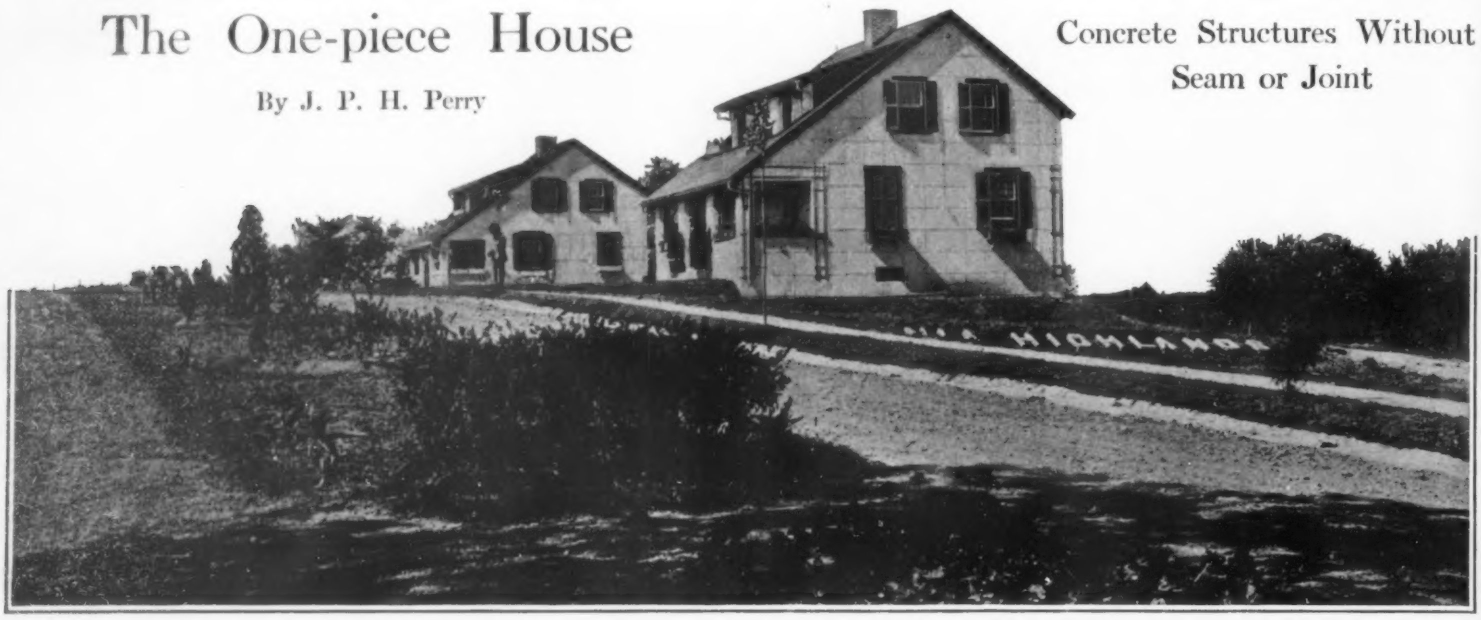
A New Type of Submarine Boat

THE Paris daily papers state that a submarine boat of a new type has just been put in service. It was constructed at the Toulon naval docks and is called the "Charles Brun." The remarkable feature about this submarine is that it is operated by a single engine which works at the surface as well as under water. According to the present statements, M. Maurice, a naval officer, invented a system of boiler such that by using a suitable storage material there is enough heat stored up while running at the surface so as to be utilized when the boat is running under water. In this way a greater speed is obtained than what prevails in the case of submarines which use storage batteries to operate electric motors. As in other submarines of the navy, the process is kept secret. During the tests the performance of the apparatus is said to have been quite satisfactory.

The One-piece House

Concrete Structures Without Seam or Joint

By J. P. H. Perry



MONOLITHIC concrete houses may be grouped into three classes, fireproof, semi-fireproof and non-fireproof, and the purpose of this article is to describe, first, how the houses included in each of these qualifications are built, and, second, to show the advantages each of these types possesses as compared with other and perhaps better known types of home construction.

By "monolithic" concrete is meant concrete poured in place in distinction to concrete made into blocks at a central point and distributed and then laid after the manner of brick work.

The fireproof concrete house is a house whose walls, floors, and roof are of reinforced concrete. It is not essential that the walls be all of concrete. Brick or field stone may be used for the exterior and the frame work of the house made of concrete, but here we shall discuss only the all-concrete house, as it is assumed that the man in the street is familiar with the stone or brick house. Despite the vigorous publicity and advertising campaign on the part of the cement manufacturer and the concrete contractor to the effect that concrete houses can be built as cheaply as the frame house, such is not the fact. A modification of the all-concrete house may perhaps be obtained at prices reasonably close to the more conventional class of house. But in the general sense of the word, a concrete house will cost considerably more money than the frame house as we know it to-day.

The construction of a concrete house is not essentially different from the construction of a reinforced concrete factory or warehouse except that it generally calls for better workmanship and more careful detail designing. To secure a *good* concrete house, a prospective builder must do two things. First, employ an architect who is familiar with the design of reinforced concrete houses and who will draw plans which he expects will be executed in concrete and which he knows can be executed in concrete. Second, to have a contractor who is experienced in this class of construction and under no circumstances let the contract to the ordinary mason builder or local builder who knows little or nothing of concrete work in general, and especially of reinforced concrete house work.

A successful concrete house cannot be obtained unless the architect and the contractor start in *from the beginning* to make a *concrete house*. Not only must the architect and the contractor work together, but they must have the active co-operation of the owner and must have appreciation on his part that he is going to get a *concrete house* and not a house built of concrete, which he expects will look like a stone or a brick house. If these conditions are met, it is entirely possible to turn out a home which will be second to none in its excellence. There are a number of magnificent concrete houses scattered throughout this country which are in every way satisfactory to all parties who have had anything to do with them. The details of the construction of these concrete houses are many and largely technical. It will be impossible within the limits of this article to go far into a description of them. One or two points may, however, be suggested for consideration.

So far, to the writer's belief, no satisfactory form or mold system other than that of wooden forms has been found. There has been considerable talk in the technical, and in fact in the popular press, about metal forms and uniform forms, etc. Up to date none of these "systems" have proven especially economical, and in only one or two instances at all practical. None of them has been adopted to any extent for large work. The design of the forms and their handling is a matter largely of experience in so putting the forms together that they will be tight to prevent leakage of the concrete and be sufficiently strong to sustain the load of wet concrete in proper alignment until the concrete has set. They must also be so designed as to be easily removed without injuring the concrete with which they have been filled. Furthermore, this process of removing or taking down forms must not demolish them completely, but must keep them as far as possible in their original shape so that they may be used again with minimum expense. The economy of concrete construction depends almost wholly upon repeated use of forms.

The materials which go to make up the concrete are in general Portland cement, clean sharp sand, well graded, and either gravel or broken stone. The choice of the gravel or broken stone will in many cases be a matter of considerable study as it is possible to obtain beautiful effects in the finished concrete with carefully selected aggregates.

The design of the floors and walls as far as their strength is concerned is a matter of pure engineering and one which has become so largely standardized at the present time that it need not be taken up here.

The chief consideration in concrete house building is the character of exterior and interior finish to be obtained. The exterior may be handled in any one of several ways. The concrete may be left as it comes from the forms, practically untouched except perhaps for slight pointing and rubbing to fill up any bolt holes or pockets and remove any irregularities on the surface; the surface may be rubbed with wire brushes to remove the thin skin of cement mortar which generally comes to the surface against the forms and thus exposes the stone or gravel composing the aggregate. This method produces a rough surface generally of uniform texture and often of interesting color; the surface may be painted with various special cement paints or may be washed with a thin grout (cement wash) which is generally done to give a more uniform color to the concrete than it is possible to obtain if the concrete is left as it came from the forms; or the exterior surface may be given a coat of stucco or plaster. The choice of these different finishes should be left to the discretion of the architect with the advice and experience of the contractor.

The interior finish depends on the treatment of the walls. One hears a great deal of popular prejudice about concrete walls being damp. As a matter of fact, a monolithic concrete wall six inches or more in thickness, if properly built of wet rich concrete is impervious to moisture. This statement can be absolutely backed up by reference to the many hundreds of concrete factories and warehouses, whose walls have not been damp-proofed or treated in any way, and whose owners have no complaints on the score of dampness. There is a slight possibility, however, of there being condensation. In all probability, if there is any condensation, it will occur on the windows and not on the walls. There is a tendency, however, toward a cold down draught in severe weather along the walls. This is noticeable if a chair is placed near the walls, and there sometimes is complaint for this reason. In house work it is generally considered good practice to fur the walls. This may be done with a hollow tile, wooden studding and lath, metal studding and lath, or plaster blocks. Also it is possible to build a monolithic wall with air spaces formed in it with the idea of preventing heat conduction, and consequent elimination of condensation.

The interior treatment, as above suggested, depends upon the way the walls are finished. If no fear of dampness or condensation is felt, the walls may be left plain concrete, as remaining after removal of forms, and paint or plaster may be applied to the surface. If furring is resorted to, ordinary house building conditions result and the plaster work goes ahead in the general manner. There has been some very good work done in treating the interior surface of concrete houses as concrete with tinting, or tile ornamentation.

There is one other point about an all-concrete house which the layman has probably raised in his mind as he reads this article, and that is concrete floors. In speaking of concrete floors, the writer has had in mind the structural or weight bearing part of the floor; this would mean the floor and its joists or beams. This will be built of reinforced concrete of sizes calculated to take the loads which they would have to carry. The floor itself may be given a sidewalk or, as it is technically termed, a granolithic finish and left in this condition, it being assumed that the occupant would lay rugs or cork matting; this has been found very satisfactory in many houses and it makes a more fireproof and more sanitary and permanent floor. Generally, however, the home builder will insist upon wooden floors and this desire is readily satisfied. A maple or other kind of wooden wearing surface may be laid on wooden sleepers imbedded in cinder concrete which rests on the structural part of the floor. There are other ways of laying wooden floors, such for instance as imbedding the top surface boards directly in a mixture of tar and sand which is laid on the structural concrete. A wooden floor laid on the structural concrete gives a very heavy and consequently a soundproof floor which is in every way satisfactory.

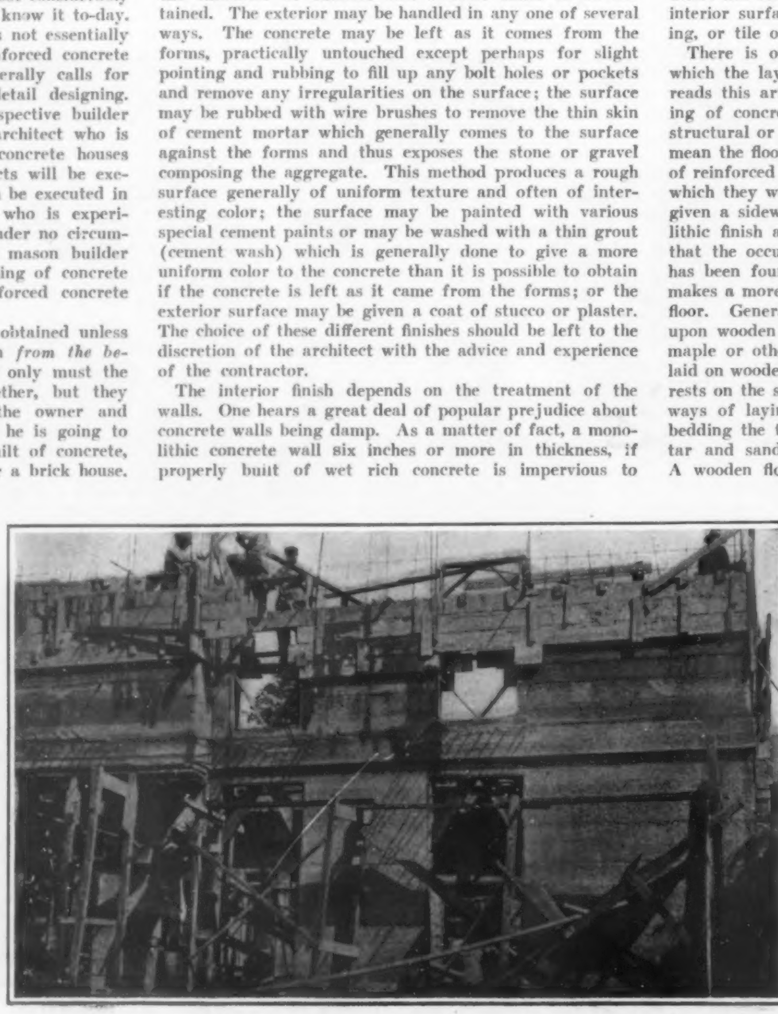
The ceilings or the under side of the floors may be made flat if desired, or the beams, or ribs, or joints can be exposed and either painted or plastered as the architect desires.

The installing of plumbing, heating, lighting and ventilating systems goes ahead in a concrete house with little more difficulty, provided proper study is given to these questions, than in the more conventional type of construction.

Chimneys, stairways, closets can all be built of concrete with entire satisfaction.

The advantages of an all-concrete house have been pointed out so frequently in the current press, and so much has been heard of the success of concrete industrial buildings, that it will suffice to hint at rather than detail these advantages.

The fireproofness of a concrete building is its primary advantage. To be sure, the insurance question on the ordinary suburban house is almost



AT WORK ON A MONOLITHIC HOUSE

negligible for the reason that the rates quoted are very low, even on the ordinary kind of fireproof structure. On the other hand the insurable value of a house and its contents really is of less importance to the owner than the real fireproofness of the house. It is impossible to recover by insurance the loss of private papers, heirlooms, works of art, and many family treasures that are irreplaceable. Furthermore, there is always the horrible probability of loss of life in a fire, and the knowledge that the home is absolutely unburnable should be worth an incalculable sum of money to its owner. A concrete house is fireproof like a stove. A stove is entirely fireproof, only its contents burning. In the event of a fire starting in any room in a concrete house, it can be confined to this room, and its damage limited.

Vermin are a source of trouble to housewives—rats, mice, roaches and other unmentionable pests have to be constantly fought in the ordinary type of house. A concrete building offers no place for vermin to hide, and it has been found that they are practically eliminated.

Repair and painting charges are a constant burden to the owner of the conventional type of house. A concrete house has no maintenance charges and does not need to be painted, but is permanent, rigid and enduring. The resistance of concrete to fire depends upon its very low conductivity, or its slow transmission of heat. For this reason a concrete house is very even temperatured; it is cool in summer, and warm in winter.

A house which can have a hose turned on it inside or out, is essentially sanitary and essentially clean. Maximum light can be obtained very readily owing to the adaptability of concrete to any form of design.

A concrete house for country work seems to fit into the landscape better than almost any other type of construction. Its color and its design seem to adapt themselves well to the surrounding landscape, and there is none of the rawness generally felt when one looks at a brick or masonry house.

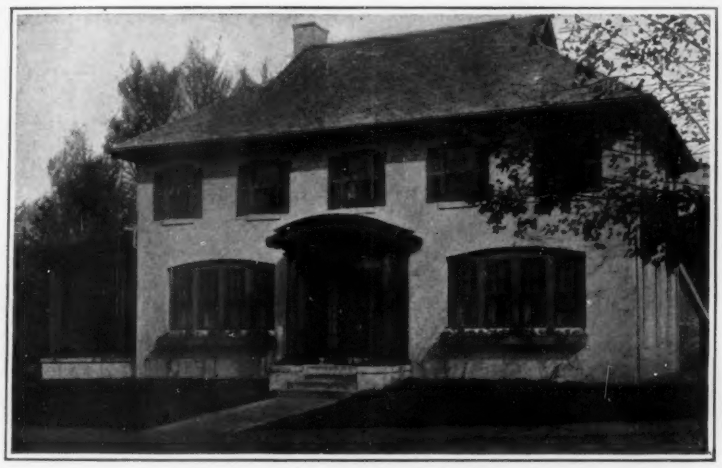
The cost of an all-concrete house is what the prospective home builder is essentially interested in. On a large house, say $50,000 and upward in value, concrete can be used as above outlined at a cost which will not exceed that of brick or masonry walls and frame interior construction, as commonly practised, by much over 10 per cent to 15 per cent, and may even not exceed it at all. Compared with an all-frame house, concrete will run perhaps 20 per cent to 30 per cent more in cost. A very large house can be built in concrete at about the same cost as in other materials of the more ordinary type.

In looking at the cost of a home, however, the owner cannot afford to be guided merely by the initial cost or contract price. The ultimate cost of a house is what really interests its builder. If insurance charges, the value of additional fire protection, repair items, depreciation charges, vermin loss, and the other annual upkeep items are considered, and evaluated, it will be found that a concrete house that appears higher in first cost, is in the end the best investment that it is possible to make in house building.

At the beginning of this article, granolithic concrete houses were divided into three classes. All that has been said heretofore, has applied to the first section, or the all-concrete house. The second class, or semi-fireproof concrete house, differs from the all-concrete house in that the walls and floors are built of concrete, whereas, the roof is built of wood framing and shingles, or wood framing and tile or slate. This type of house is somewhat less expensive than the all-concrete house and in many instances nearly equal in its advantages. Of course, in the ordinary detached house, there is little danger of fire except from the interior, and if the roof is burned off, the rest of the house is not seriously damaged, the accident resulting in little more than inconvenience. The repairs and upkeep of a roof of this character have to be considered and it will in many cases be found profitable to spend a little more money and get a concrete roof than to try to economize. In talking of a concrete roof, the idea should not be obtained that no "roofing" will be necessary. It is practically impossible to build a concrete roof which would be watertight unless it is treated with tar and roofing felt covered with gravel or slag. If it is preferred, slate or special tile can be used with concrete advantageously. In designing roofs for concrete houses, every effort should be made to keep the roof flat, so that the costs of the forms for forming the concrete are not expensive. If peaked, or gambrel roofs are shown on the plans, the cost of constructing the same in concrete comes very high. The design of a concrete house can be made most acceptable if flat roofs or very slightly sloping roofs are specified.

The other class of monolithic house noted herein is nonfireproof and contemplates the use of concrete only for the foundation and walls, the interior and roof being all wood or other material. This house is in no sense fireproof, though it is unquestionably more fireproof than an all-frame house in that in the event of fire the walls at least will be left standing, and ready for use again. This type of house has several advantages over the ordinary

(*Continued on page 292.*)



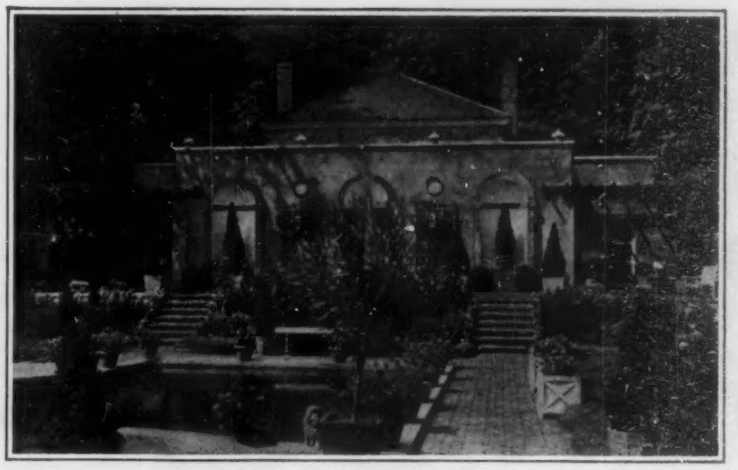
Simplicity of treatment is not inconsistent with beauty of effect.

House of solid concrete, roof included.

House at Highlands, Mass., made of solid concrete.

Bungalow of pleasing design at Bryn Mawr, N. Y.

An ambitious bungalow in North Carolina.



Concrete studio in a charming setting.

A GROUP OF MONOLITHIC CONCRETE HOUSES SHOWING GREAT DIVERSITY OF TREATMENT

The Cement Market

Conditions of Manufacture and How They Benefit the Consumer

By Allen E. Beals

STRANGELY varied is the picture presented to us when we summon up before our mind's eye the many uses to which cement is put to-day. The American farmer uses it to make hen's nests that give no harbor to insect pests, that can be scrubbed and baked, thus insuring absolute disinfection. Of cement are made such varied structures as a pig sty, a freight barge, and the rampart of a fortress. Science has shown that a nest egg made of Portland cement is cheaper and more permanent than a china one, and with the same material a great government is building the world's greatest waterway. Like electricity, cement seems to be destined to render to mankind services whose extent can hardly be properly realized; and the public mind weaves a romantic future for it.

Imagination almost quails at the vast amount of capital invested in this industrial prodigy. The investment in the United States alone is roughly estimated at $600,000,000, and the industry is only two score years old in America. Graphic illustration only can give the layman an idea of its phenomenal growth.

Between 1870 and 1879 the total output of Portland cement in the United States was 82,000 barrels. This does not include output figures for Puzzolan and natural cements. American mills alone turn out 6,000,000 barrels a month to-day. This contemplates a daily consumption of 200,000 barrels, assuming that construction work, as cement manufacture, continues uninterrupted seven days in the week. This represents a total output in 1910 of 74,000,000 barrels. One company shipped a daily average of 5,500 barrels to the Panama Canal, or a little more than 2,000,000 barrels in 1910.

If nine trains, each ten miles long, aggregating to a total of 14,000 freight cars, could be procured to handle this great 1910 shipment, they would barely be able to haul the total shipment in one load. If this vast quantity of Portland cement were to be placed in a single barrel proportioned exactly as an ordinary cement barrel is patterned, it would measure 294 feet high. Its weight would be 800,000,000 pounds, or 400,000 short tons. Some idea of the size of this barrel may be gained by stating that the "Mauretania," with its 32,500 gross tonnage, would have to make several trips to carry the contents of this great cask of Portland cement, or, were it imperative to move it in one journey, it would be necessary to hitch three of these giant ocean greyhounds together abreast to make room for the machinery to propel the vessels.

Picture to yourself a barrel of Portland cement reaching to within a few feet of the top of the Eiffel tower, the top of the lantern of which is 984 feet above the street level, or so high that the famous Flatiron Building in New York city would have to be placed upon the top of the Metropolitan Building, the world's tallest inhabited structure, before an engineer could reach the top to get at the contents of the barrel. This will give a fair idea of the size of the receptacle that would be required to contain the total output of Portland cement in the United States in 1910. This barrel would weigh 29,600,000,000 pounds on the basis of 400 pounds gross to a barrel (the weight of a barrel of cement being computed at 380 pounds net to the barrel, and the barrel itself weighing 20 pounds).

One cannot conceive of such a weight until it is stated that if every man, woman and child in the United States weighed 150 pounds, the total weight of our portion of humanity, based upon the 90,000,000 of population at the last census, would be only 13,500,000,000 pounds, and our barrel would still have 16,100,000,000 pounds to its advantage.

These totals are staggering when the output for the nine years between 1870 and 1879 is considered. The total output for that period would have gone into a barrel only 100 feet high or as tall as a six and one-half story building. The rate of growth and corresponding decline in prices and indication of bulk by periods in the industry are shown in this table:

Year.	Quantity Manufactured, Barrels.	Price per Barrel Represented in 25-Cent Pieces.	Height of Imaginary Barrel
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One would suppose that under such wonderful strides in development cement producing companies would be reaping tremendous profits. Here is the tragic side of the industry.

The prospects of quick returns upon investments and the exploiting of production figures have been a source of much profit to the promoter, whether the same be true of the investor or not. There are 103 plants in this country to-day. More will start this spring. Each company is producing just as much as it can regardless of market conditions. In consequence many companies were sorely squeezed last year, when competition was conscienceless.

The following statistics show the wonderful growth of the industry and also the decadence in prices:

	Number Barrels Produced.	Value.	Price per Barrel at Mill.
1870 to 1879	82,000	$246,000	$3.00
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1882	85,000	191,250	2.01
1883	90,000	$193,500	2.15
1884	100,000	210.000	2.10
1885	150,000	292,500	1.95
1886	150,000	292,000	1.95
1887	250,000	487,500	1.95
1888	250,000	480,000	1.95
1889	300,000	500,000	1.67
1890	335,500	704,000	2.09
1891	454,813	967,429	2.13
1892	547,440	1,153,600	2.11
1893	590,625	1,158,138	1.91
1894	789,575	1.283,473	1.73
1895	990,324	1,586,830	1.60
1896	1,543,023	2,424,011	1.57
1897	2,677,775	4,315,891	1.61
1898	3,692,284	5,970,773	1.62
1899	5,652,266	8,074,371	1.43
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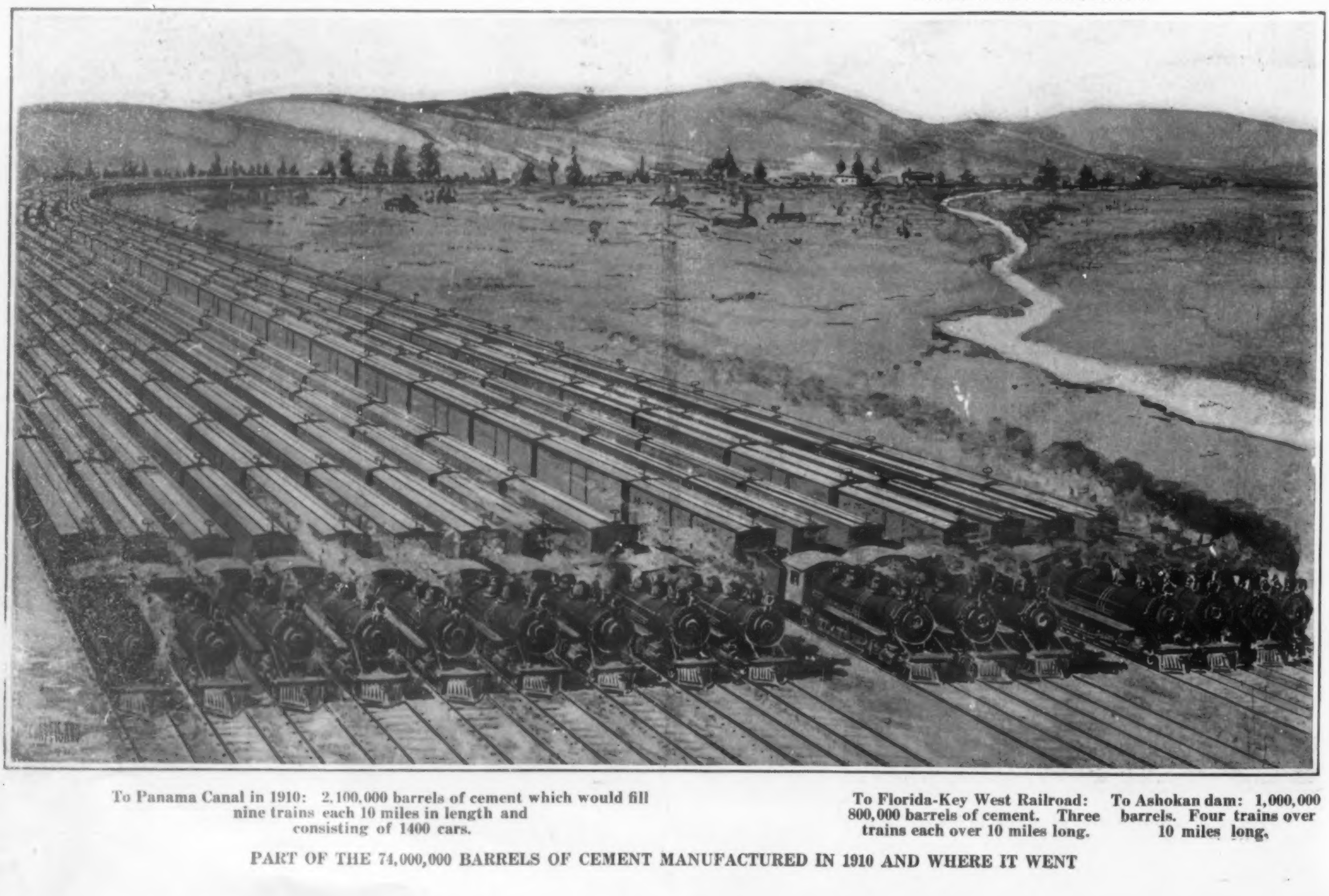

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The character of modern concrete and that of ancient concrete is vastly different. Joseph Apsdin did not rediscover a lost art. The ancients in the centuries B. C., as well as early A. D., employed concrete extensively and obtained permanent and lasting results without the use of a hydraulic cement. Their concrete, however, acquired its strength slowly, which in those days very probably was considered economical, as the ancients built slowly. Their concrete was not made of a pre-determined mixture manufactured into a cement or bonding material. Instead they used the materials furnished by nature in the form of lime, clays, volcanic rocks and gravel. These were mixed together in proportions which would result in maximum density, placed in board forms or molds—very similar to those of the present day—and allowed to remain in place for a considerable length of time until sufficiently hard to support the weight for which the concrete was intended.

There is a large amount of concrete in the Roman Forum, used as foundations for the temples and other buildings. It is still in place and plainly shows the board marks, the grain of the wood and the spaces where the bracing was taken out.

There was no concrete used in building the pyramids in Egypt. There was, however, a so-called mortar used on the outside as a plaster to even up the surface. This was only on some of the pyramids; on others triangles of stone were set in the steps to serve the same purpose. The materials used in Egypt were lime, clay and gravel mixed with water. In Rome the probable materials used were lime, ground lava from Vesuvius, clay and gravel mixed with water. The Moors built the walls and watch towers of the Alhambra, Granada, of a concrete composed of lime, clay and gravel. The holes where the braces went through the concrete holding the board forms together are plainly visible. The tower at the end of the walk is entirely of concrete and extends on the opposite side down to the moat, a distance of about 75 feet. This picture was taken by the author in 1907. A peculiarity of this concrete made by the Moors was that they realized the weakness of their material during the early stages of setting, and placed a stratum of about a half inch in thickness of lime every foot. These strata were horizontal and ran through the wall. The lime would harden more quickly than the mixture of lime, clay and gravel, and would tend to give stability to the wall so that the forms might be taken down at an early date.

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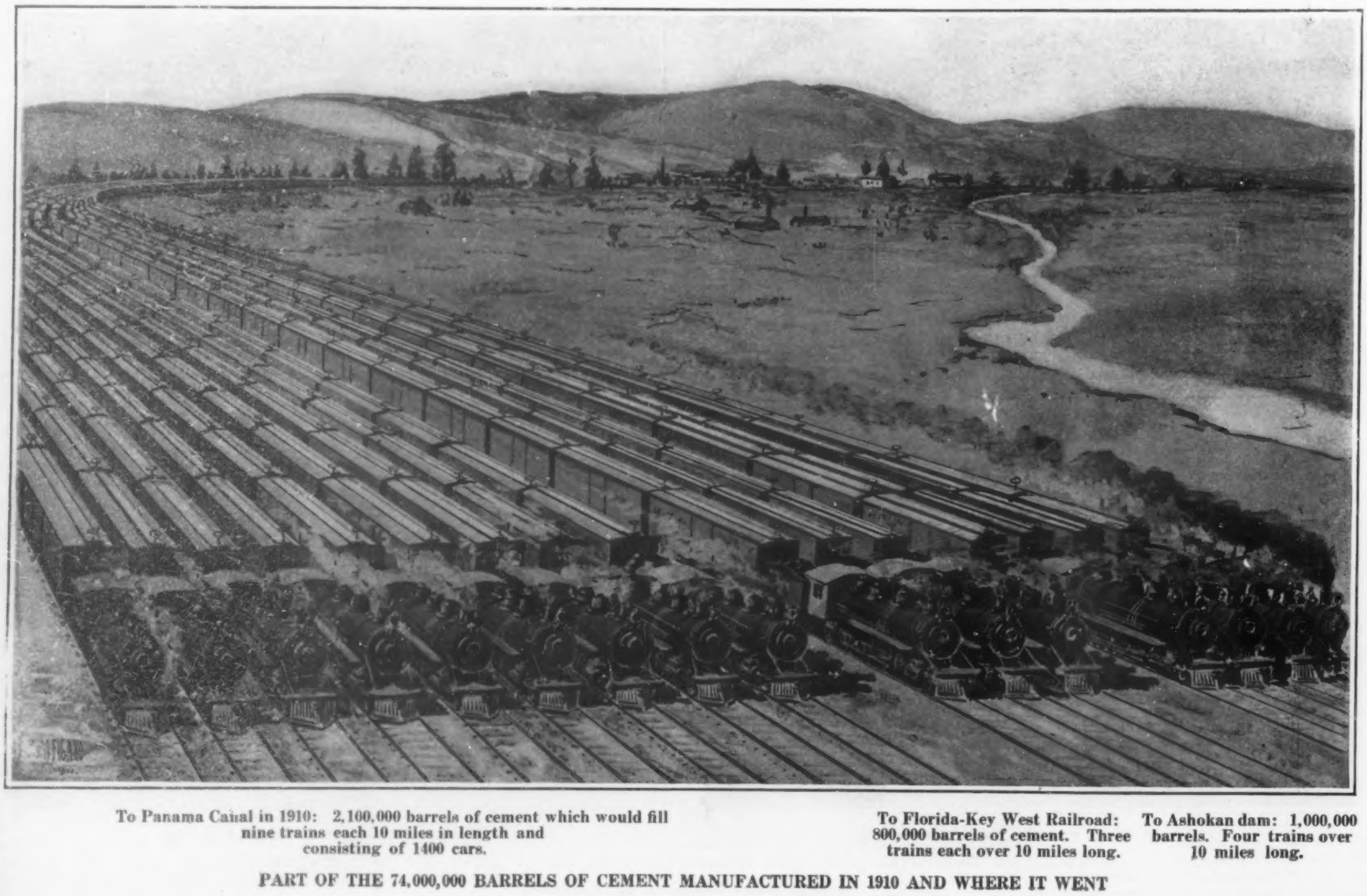

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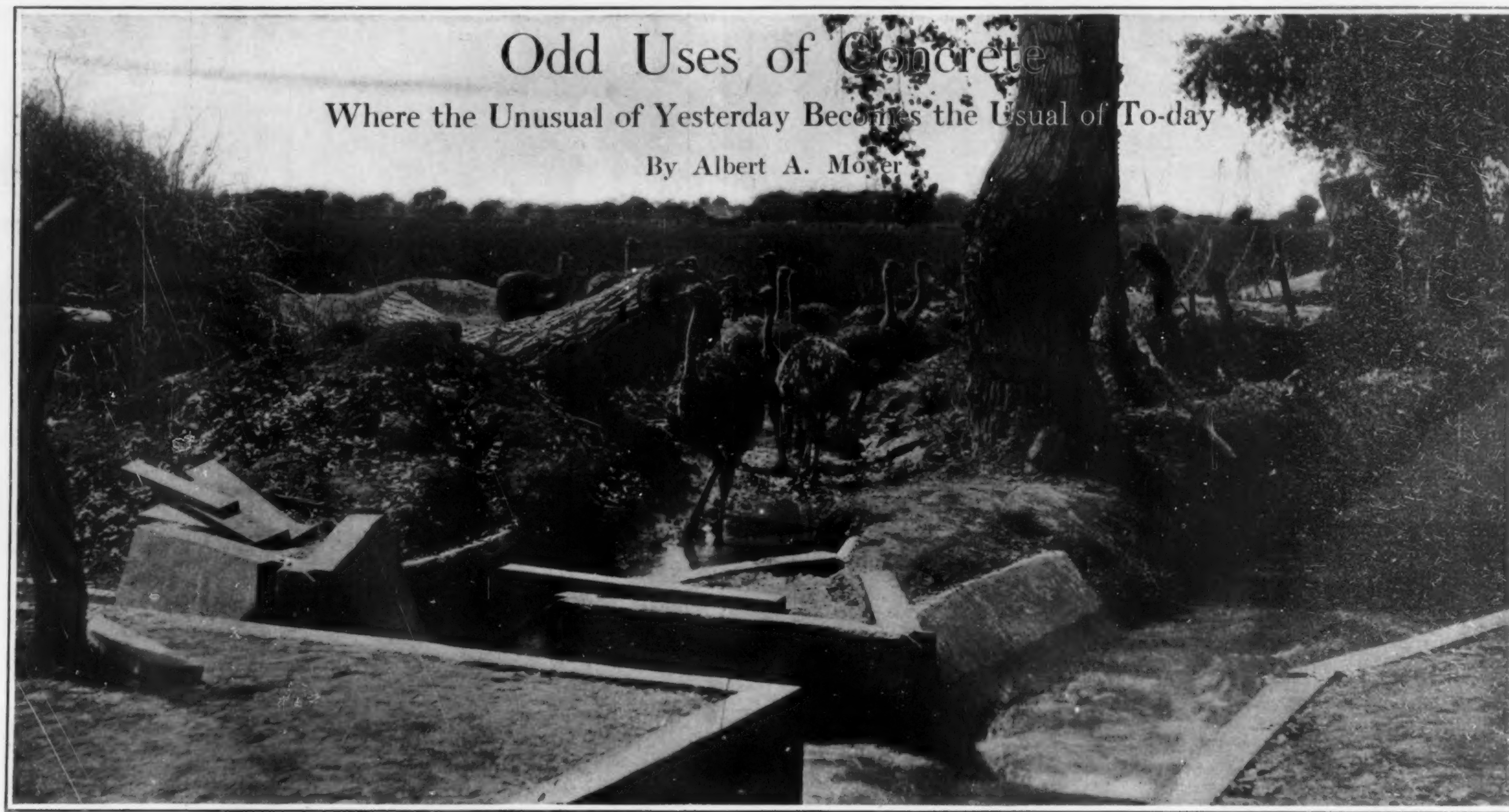

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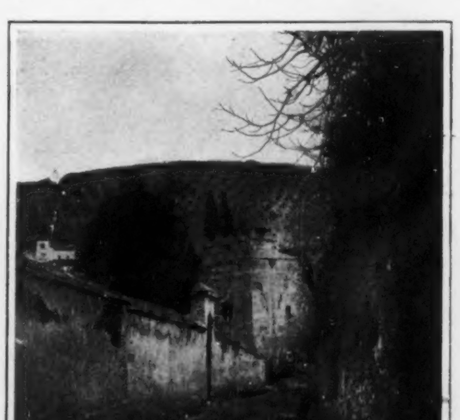

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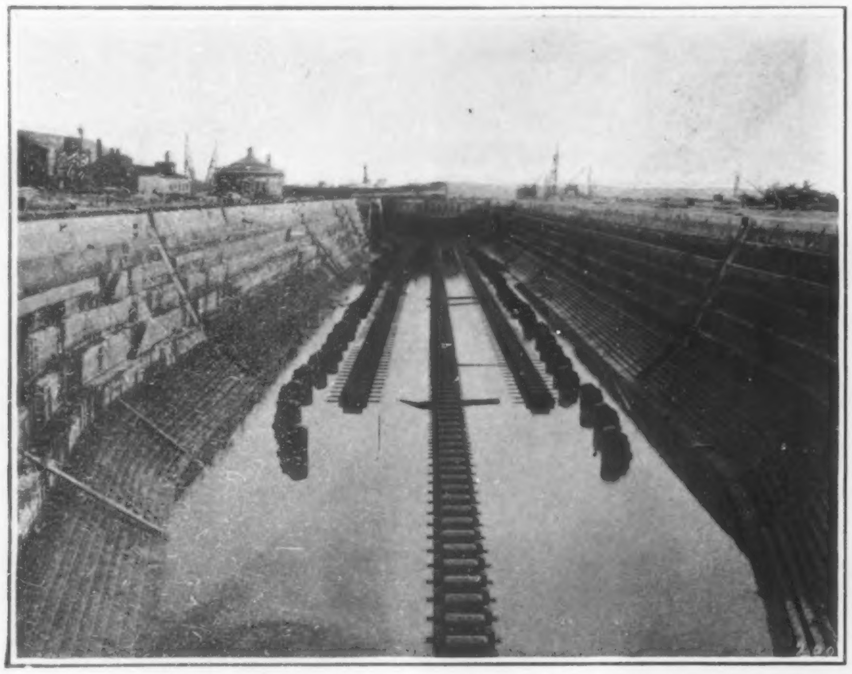
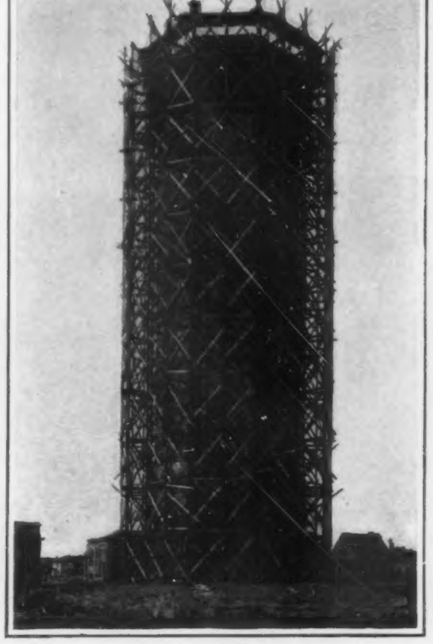
Polychrome urn made of black and yellow aggregates.

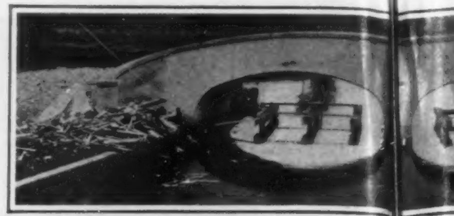
ODD USES OF CONCRETE



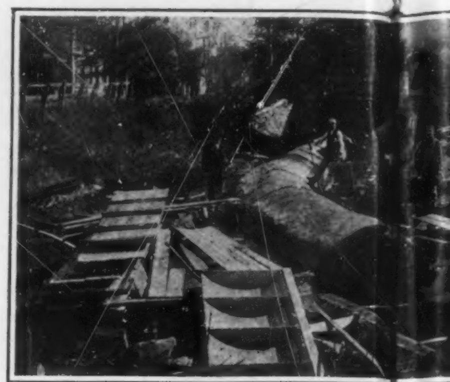
Drydock at the League Island Navy Yard, Philadelphia.



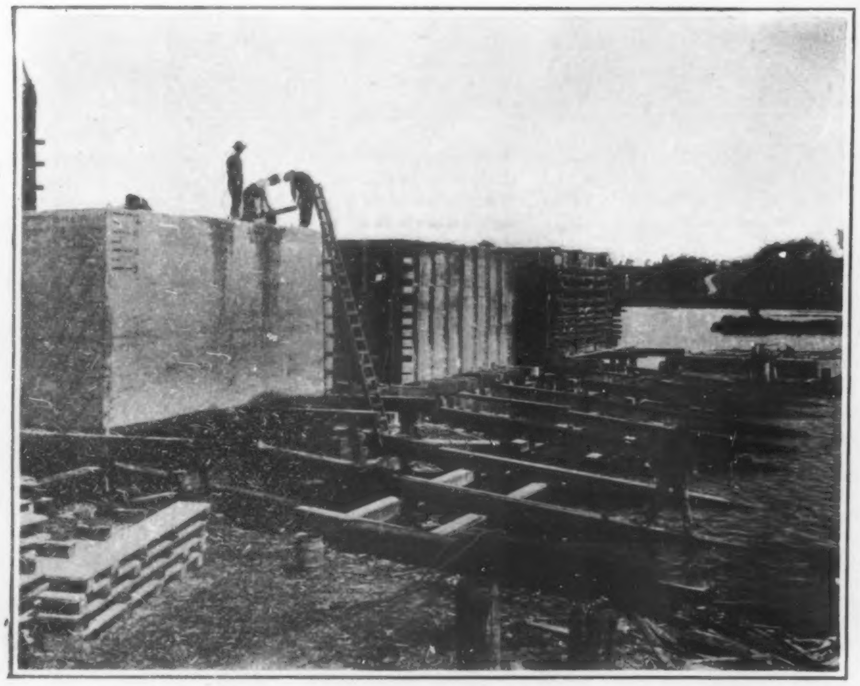
Building a concrete water tank.



Reinforced concrete bridge simple

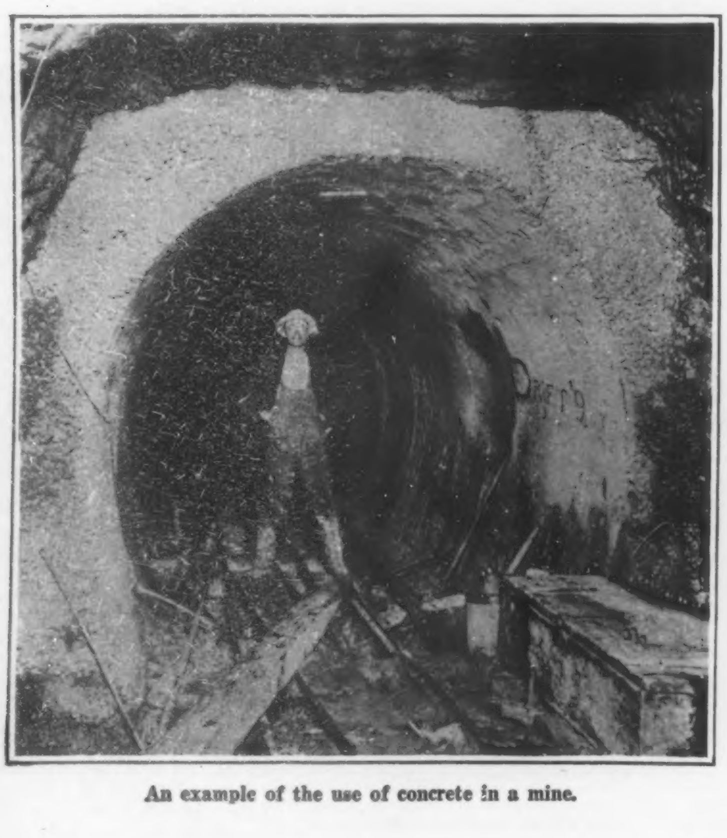


Concrete pipe 300



Floatable reinforced concrete caissons, government breakwater, Algoma, Wisconsin.

Ice house with walls of cement plaster on expanded metal lath.

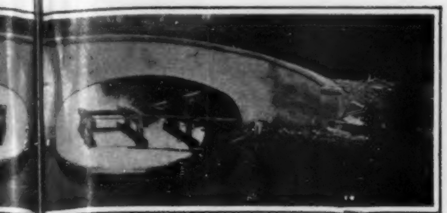


An example of the use of concrete in a mine.

A pleasing example of concrete block work.

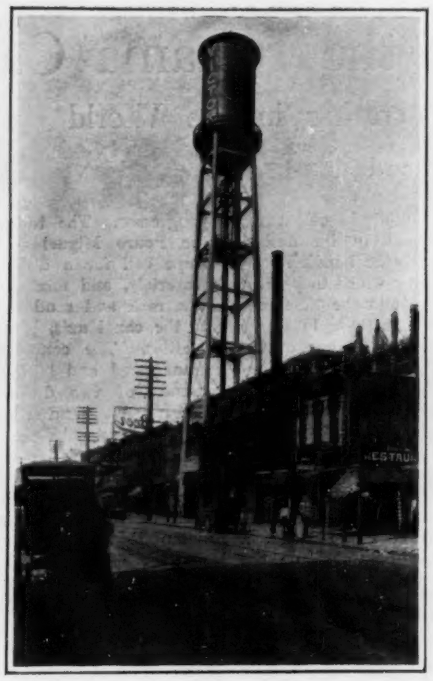
Re

THE WIDE ADAPTABILITY

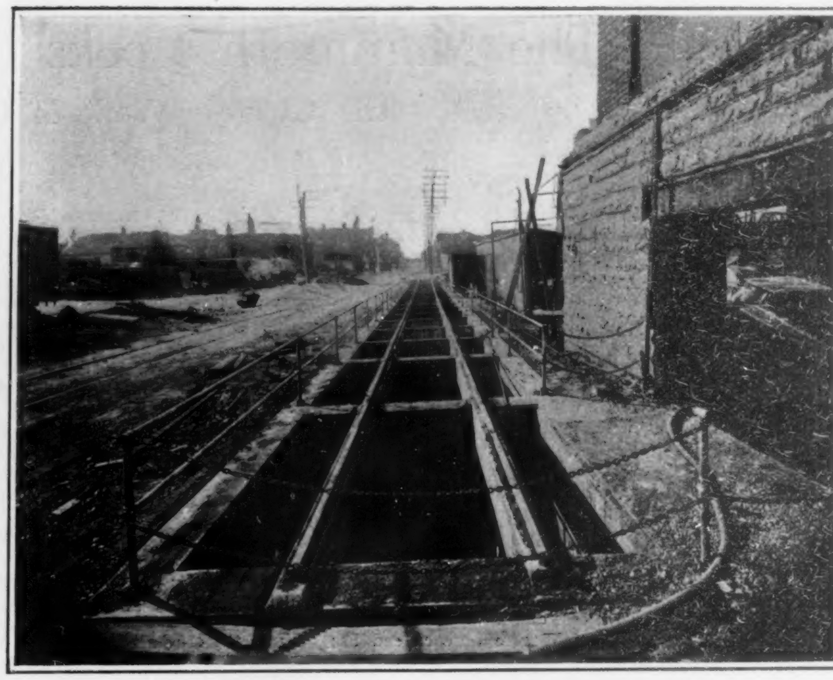


dge of simple but graceful design.

te pipe 300 feet long.

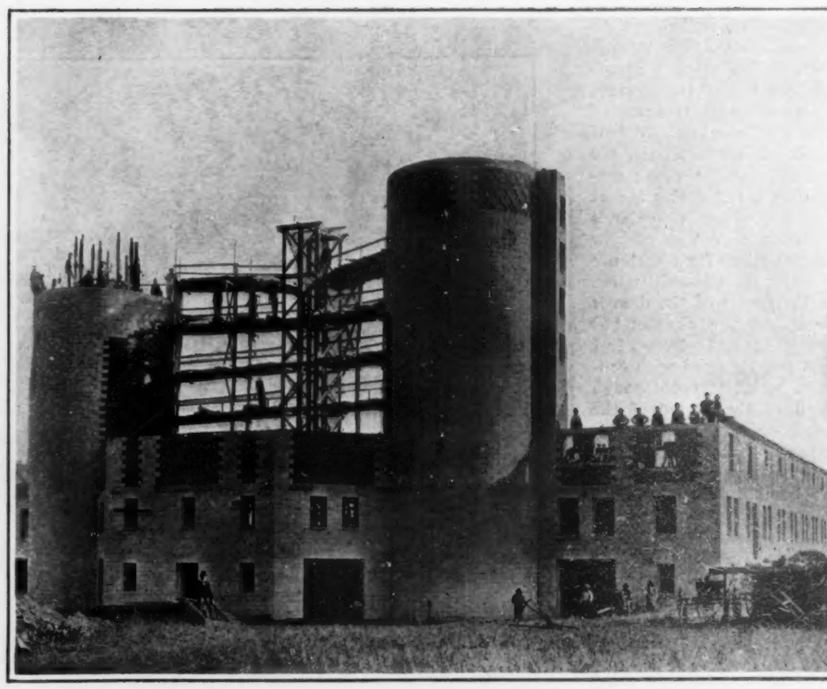


Steel tower incased in concrete to save cost of upkeep.

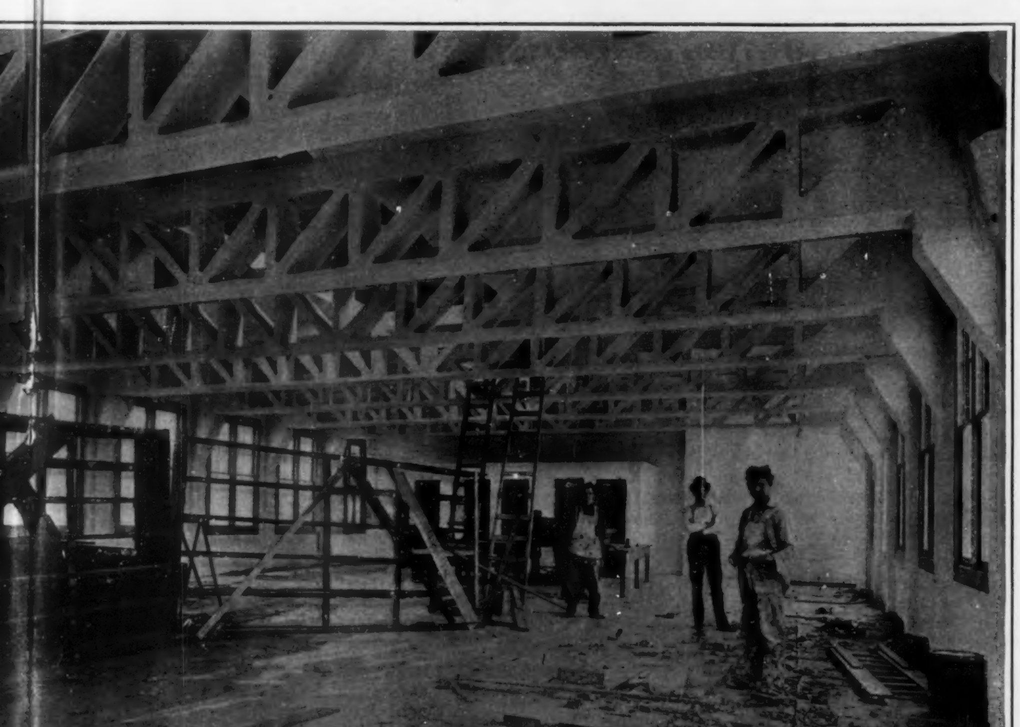


Discharge pits made of reinforced concrete.

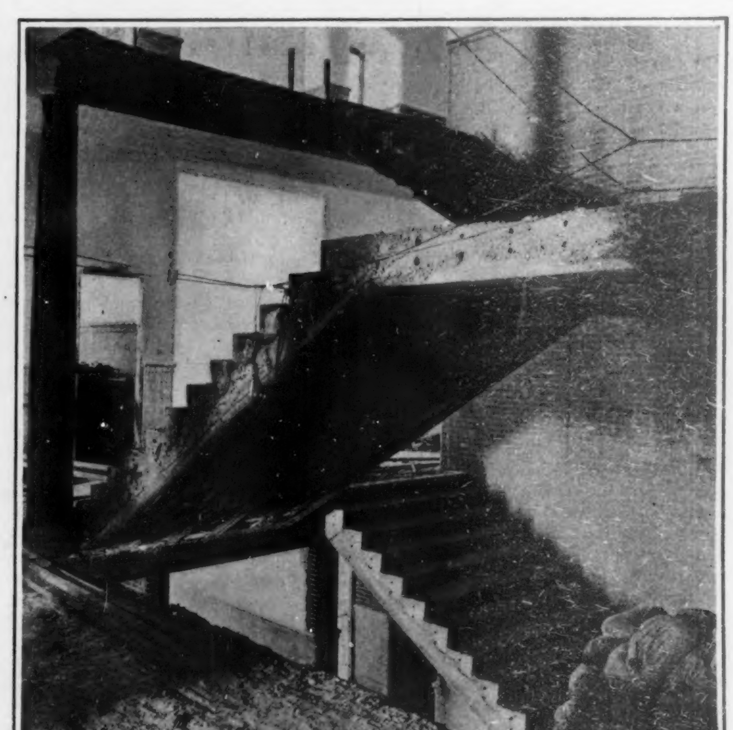
How cement can be used to advantage for staircases.



Two silos and a building of cement blocks in course of construction.



Reinforced concrete girders built on the ground and hoisted to position.



Example of the rigidity of concrete.

ITY OF PORTLAND CEMENT

The Mammoth Locks of the Panama Canal

The Greatest Work of Concreting in the World

By Walter Bernard

IT is scarcely possible to talk of the Panama Canal without drifting into the superlative mood; so greatly does this unique work exceed any other of the kind yet attempted. Particularly impressive are the figures which tell the story of the quantities in the huge monolithic structures, locks, dams, spillways, channelways, et cetera, which go to swell the total amount of concrete in the finished canal to five million cubic yards.

There will be twelve locks in the canal, all in duplicate. At Gatun, about six miles from the Atlantic, there will be three pairs in flight, which will serve to lift the shipping from tidewater level to that of Gatun Lake, whose surface is 85 feet above mean tide. At Pedro Miguel, on the Pacific slope, there will be one pair of locks with a lift of 30 1/3 feet, and a little nearer the Pacific, at Miraflores, two pairs of locks, with a combined lift of 54 2/3 feet, will serve to bring the ships down to mean tide level on the Pacific.

The dimensions of the locks are all the same, each having a usable length of 1,000 feet and a width of 110 feet. Each lock, when the water-tight gate at each end has been closed, will form a vast chamber with walls and floor of solid concrete.

The greatest single structure of all will be the vast monolithic concrete mass which will form the triple flight at Gatun. Incidentally, it may be mentioned that these locks are being built through a low hill or mound, which is located at the easterly end of the Gatun dam, a vast artificial rampart of sand and clay, nearly half a mile wide at its base, 400 feet wide at the water surface, and 100 feet wide at the top, which extends across the valley of the Chagres River for a distance of one and one-half miles. At the center of the dam is the spillway, a channel 300 feet wide and 1,200 feet long, heavily lined with concrete, which is cut through a hill at the center of the dam, the bottom of this opening being about ten feet above sea level. During the construction of the dam the Chagres River is being allowed to flow through this opening. When the construction has advanced sufficiently to permit the Gatun Lake to be formed, the spillway will be closed with a concrete dam and fitted with gates for regulating the water level of the lake.

The Gatun locks will form a single concrete mass 3,800 feet in length and 380 feet in width. It consists of two side walls and a central division wall. The floor consists of a mass of concrete, 20 feet in maximum thickness. The side walls are 45 to 50 feet in width at the surface of the floor, and taper on their outer face from a point 24 1/3 feet above the floor, to a minimum width of 8 feet at the top. The middle wall is 60 feet wide throughout, and about 81 feet high. In the center wall will be a tunnel divided into three stories or galleries; the lowest for drainage, the center for electric wiring for the gate and valve machinery, and the upper one for the use of the operators. The lock chambers will be filled and emptied through lateral culverts in the floors, connecting with main culverts 18 feet in diameter, formed in the side and center walls.

The lock gates will be of steel, built on the cellular principle. They will be 7 feet thick, 65 feet long, and from 47 to 82 feet high. They will weigh from 300 to 600 tons apiece. Ninety-two separate leaves will be required for the entire canal, their total weight being 51,000 tons, which is about the amount of steel that was required for the construction of twenty miles of the New York Central, and is about ten per cent more than the total amount of steel needed to build the Manhattan Bridge over the East River.

No vessel will be allowed to pass through the locks under its own power. Heavy electric locomotives will take the tow ropes from the vessels and draw them into and through the locks. Electricity also will be used to operate all valves and gates in the locks, the power being generated by water turbines utilizing the 85-foot head created by the formation of the Gatun Lake.

Before proceeding to a description of the construction of the locks, it should be mentioned that Gatun Lake will constitute an inland sea of considerable dimensions. It will cover a total area of 164 square miles, and it will provide a depth in the ship channel varying from 85 to 45 feet.

It will be understood that the plant employed in the construction of structures of this magnitude called for the exercise of much careful thought in its design. Where great masses of material are to be handled it is essential to cut down the distances over which they must be moved, the number of re-handlings and the time consumed to as low a minimum as possible; for in works of this extensive character the labor cost is one of the most serious items. The plant at Gatun is being used for all the locks. The locks at Pedro Miguel and at Miraflores demand, of course, separate material handling plants. They differ from that at Gatun in details, though not in principle. It will be sufficient for the present purpose to describe the arrangements at Gatun, where over two million cubic yards of concrete must be laid in place.

The crushed stone is brought from Porto Bello, a small hamlet about twenty miles east of Colon, on the Atlantic coast. The rock is loaded at the quarry by steam shovels onto cars, which run by gravity to the giant crushers, where it is reduced to the desired size. From the crushers it falls into cars which run again by gravity to storage bins at the harbor front. Here it is unloaded by gravity into barges, which are towed from Porto Bello to Cristobal, at the Atlantic entrance to the canal, and through the old French channel to the docks at Gatun. Here are located a huge cement shed, a sand pile and a crushed rock pile. Spanning the canal, the cement shed and the sand and rock piles is a series of single and duplex cableways, the distance between the towers being 800 feet, and by means of these cableways and their grab buckets the rock is unloaded from the barges onto the stock pile.

The sand is brought from Nombre de Dios, about forty miles along the coast from Colon. It is taken from the sand pits or dug up from the beach, by clam-shell buckets, loaded into the barges, taken to the docks at Gatun and unloaded by the cableways onto the sand pile.

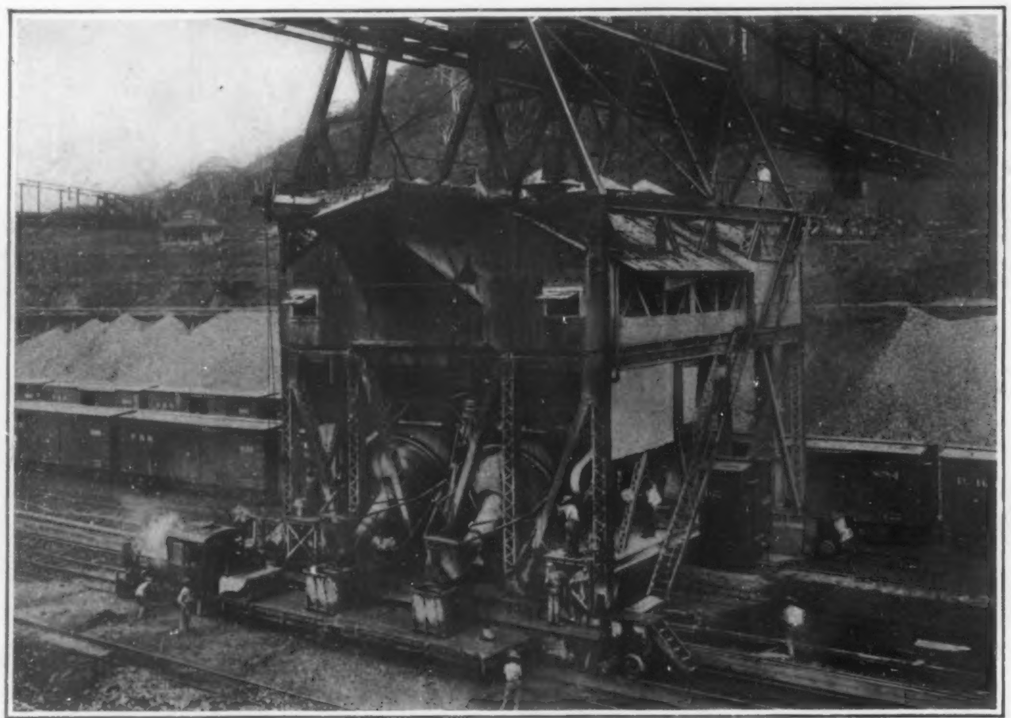
The cement is shipped in barrels from New York to Colon, where it is transferred to barges, towed through the old French channel to Gatun, and unloaded and stored in the cement shed. The latter has a capacity of about 100,000 barrels. The rock and sand storage piles have each a capacity of about 300,000 cubic yards. Below the cement shed and the rock pile are laid a series of tracks, to the cars of which the rock, sand and cement are delivered by gravity, and transferred to a series of large concrete mixing machines, located adjacent to the lock site. After the concrete is mixed, it is dumped into buckets set on flat cars, which run on electrically operated delivery tracks, which extend adjacent and parallel to the locks. From the cars the cement is picked up by the hoisting and transporting gear of a series of large cableways, each with a span of 800 feet, which reach entirely across the lock site, and is carried to the point at which the concrete is to be dumped.

After the floor of the locks has been laid and has set, the walls are erected between large plate-steel forms, which, for the inner vertical walls, present faces over 30 feet wide and about 80 feet in height. These forms are built as movable tower structures, and they can be shifted from point to point as the building of the walls progresses. The topographical and other conditions at the Pedro Miguel and Miraflores locks on the Pacific slope call for a different arrangement for handling the materials, and mixing and laying in place the concrete. The rock and sand are deposited in stock piles parallel to the canal axis, being brought to the site on railroad trestles. The concrete is mixed at the site and it is transferred and laid by means of eight huge cantilever cranes, of two different types, known respectively as berm cranes and chamber cranes. The berm cranes operate on tracks parallel and external to the lock site. They pick up the sand and rock from the stock pile, and drop it into the mixers, and after the concrete has been mixed, they transfer it to the chamber cranes, which in their turn carry the material to the desired location and dump it into place in the side walls, or wherever desired.

Everything is on a colossal scale. Thus at Pedro Miguel the total storage capacity of the piles is 45,000 and 55,000 cubic yards of sand and stone respectively, a capacity which will supply the mixers for seventeen days of eight hours. The two berm cranes used at Pedro Miguel are installed between the stock piles on two parallel five-foot gage tracks spaced 50 feet between centers. Each crane consists of a tower 50 by 40 feet and balanced-cantilever arms that extend well over the storage piles. Two and one-half cubic yard buckets, supported and operated from trolley tracks on the cantilever trestles, pick up the sand and stone from the storage piles, and unload it into bins on the crane towers. Beneath the bins is a cement floor, accommodating 6,000 barrels of cement. The mixers are two-yard machines operated by electric motors. Power for operating the cranes is transmitted by an overhead line at 550 volts pressure.

The chamber cranes consist of a tower 56 by 40 feet, carried on trucks which run on tracks laid on the floor of the lock. Each tower supports a cantilever arm 53½ feet long, extending over the center wall, and one 81½ feet long reaching over the side wall. A generally similar plant is being used at the Miraflores locks.

The construction of the locks has proceeded so satisfactorily that there is every prospect of the whole of the five million cubic yards of work being completed at least twelve months before the date, January 1st, 1915, set by Col. Goethals for the opening of the canal.



Pedro Miguel locks. The concrete mixers in base of crane towers loading concrete into buckets on flat cars.

Shell the Victor Over Armor

By Newton Forrest

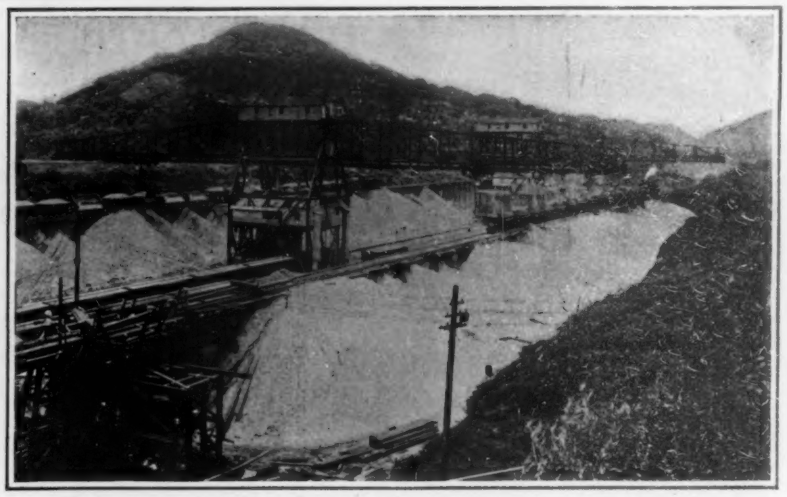
CONGRESS about a year ago appropriated $100,000 for ordnance development in the navy. This sum had a string tied to it, however, in the shape of two conditions which were to be complied with before the fund would become available. The first condition as specified by Congress was that the navy was to demonstrate that projectiles fired from a high-powered service gun would penetrate the heavy turret and belt armor of a warship at battle range; the second provided for an experiment to demonstrate the effect of 200 pounds of explosive gelatine exploded in unconfined charges against the heavy turret and belt armor of a vessel.

These two tests have been carried out, and with such satisfactory results that the navy now gets its $100,000 for ordnance development.

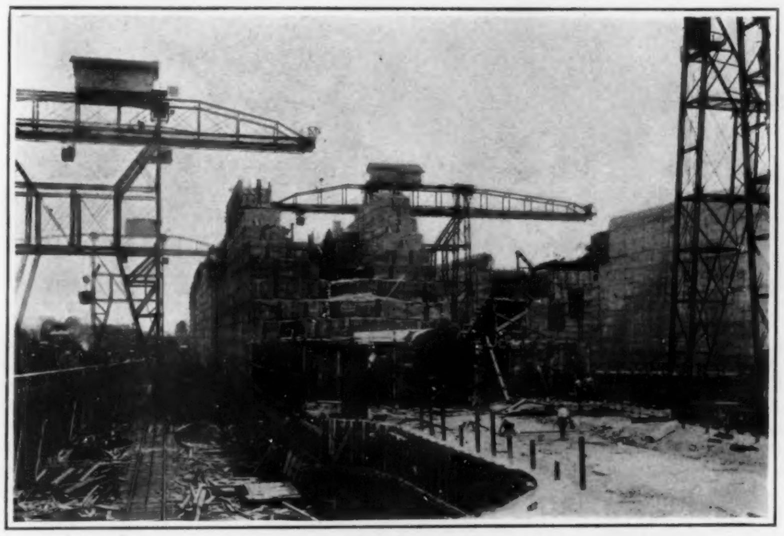
The naval experts, probably for some good reason, undertook to carry out the second condition first, and as a result thereof the monitor "Puritan" lies at the bottom of the waters in Hampton Roads, where a wrecking company is endeavoring to raise her out of the mud. When the monitor is raised and brought to dock a comparison of the damage wrought by the armor-piercing shells fired at high velocity—the first condition—with the injuries to the "Puritan," accomplished by the explosive gelatine, will be carefully made.

The test under the specifications of the first condition was duly carried out on February 10th. The demonstration took place at the mouth of the Potomac River, the monitor "Tallahassee" firing ten 12-inch shells at two targets of armor plates varying in thickness from 8 to 11 inches. These were erected on the ram "Katahdin,"

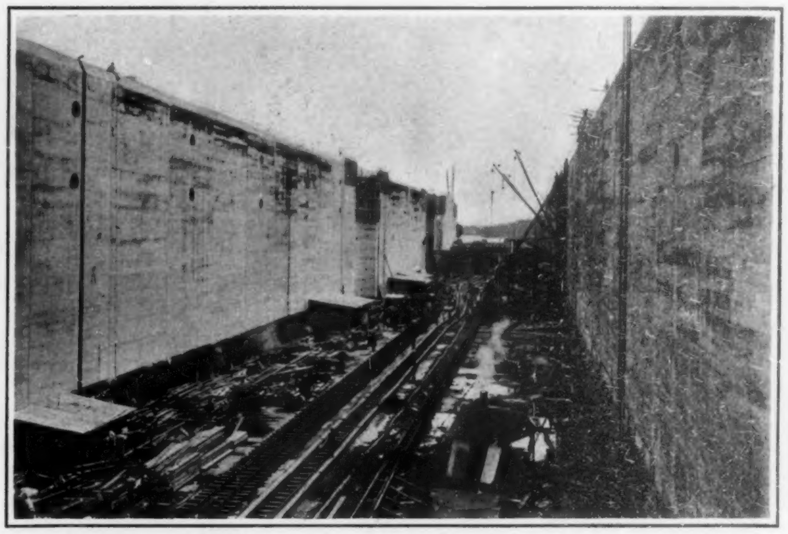
Quarrying rock for the 2,000,000 cubic feet of concrete at Gatun. Note crusher house and storage bin.



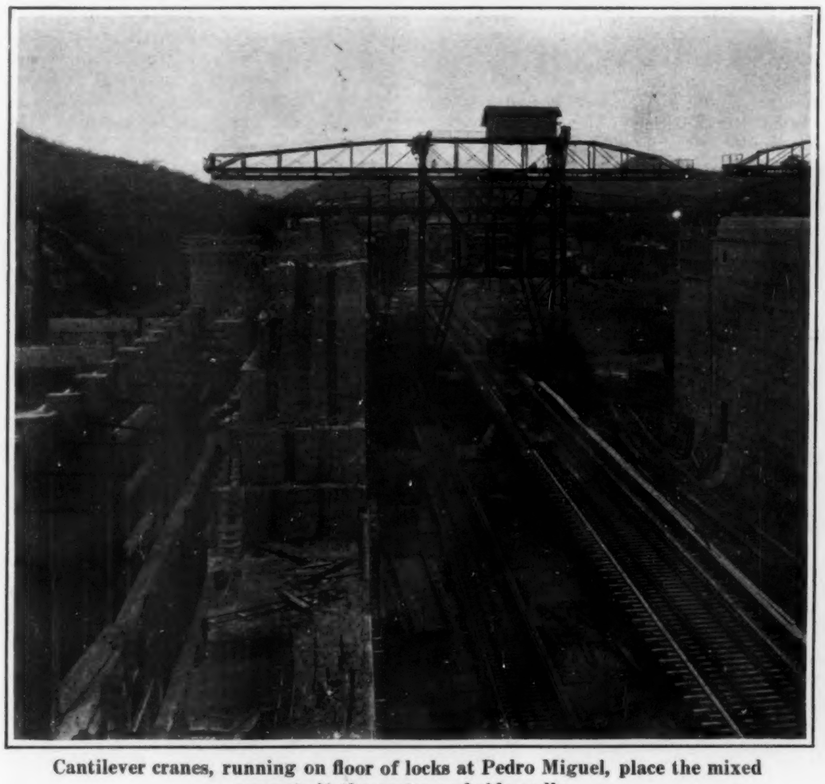
Pedro Miguel locks, showing stock piles of sand and rock and two of the mixing cranes.



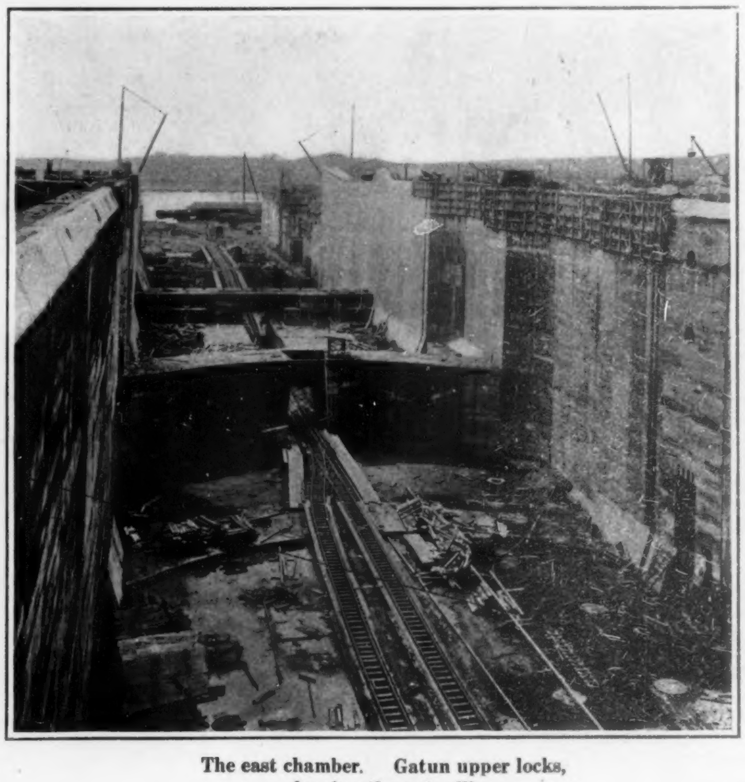
Pedro Miguel locks. Cantilever cranes constructing the center wall.



A finished upper lock chamber at Gatun. Width 110 feet, usable length 1,000 feet.



Cantilever cranes, running on floor of locks at Pedro Miguel, place the mixed concrete in the center and side walls.



The east chamber. Gatun upper locks, showing the gate sills.

THE PANAMA LOCKS (5,000,000 CUBIC YARDS) ARE THE BIGGEST CONCRETE WORK YET UNDERTAKEN

anchored some 8,000 yards—about five miles—distance from the "Tallahassee." The targets were of the most recent type of shell-resisting armor plate, representing the turret and belt armor of a modern battleship. Four of the shells fired hit and pierced the plates completely, thereby proving that for a while, at least, the gun is mightier than the armor.

The targets were erected as a superstructure on the ram. One was twelve feet high by sixteen feet wide, and the other twenty feet high by thirty-five feet wide. Some of the armor plates were flat and some curved, in order that the conditions might be as near to those met in actual warfare as possible. The projectiles fired weighed 870 pounds, and each target was hit twice by these missiles flying with an initial velocity of 2,400 feet per second. In view of the long range and the size of the targets the record made in hits is considered to be a fine one, two or three of the first shots being merely "finders." The ram "Katahdin" was not damaged.

It is now up to the armor experts!

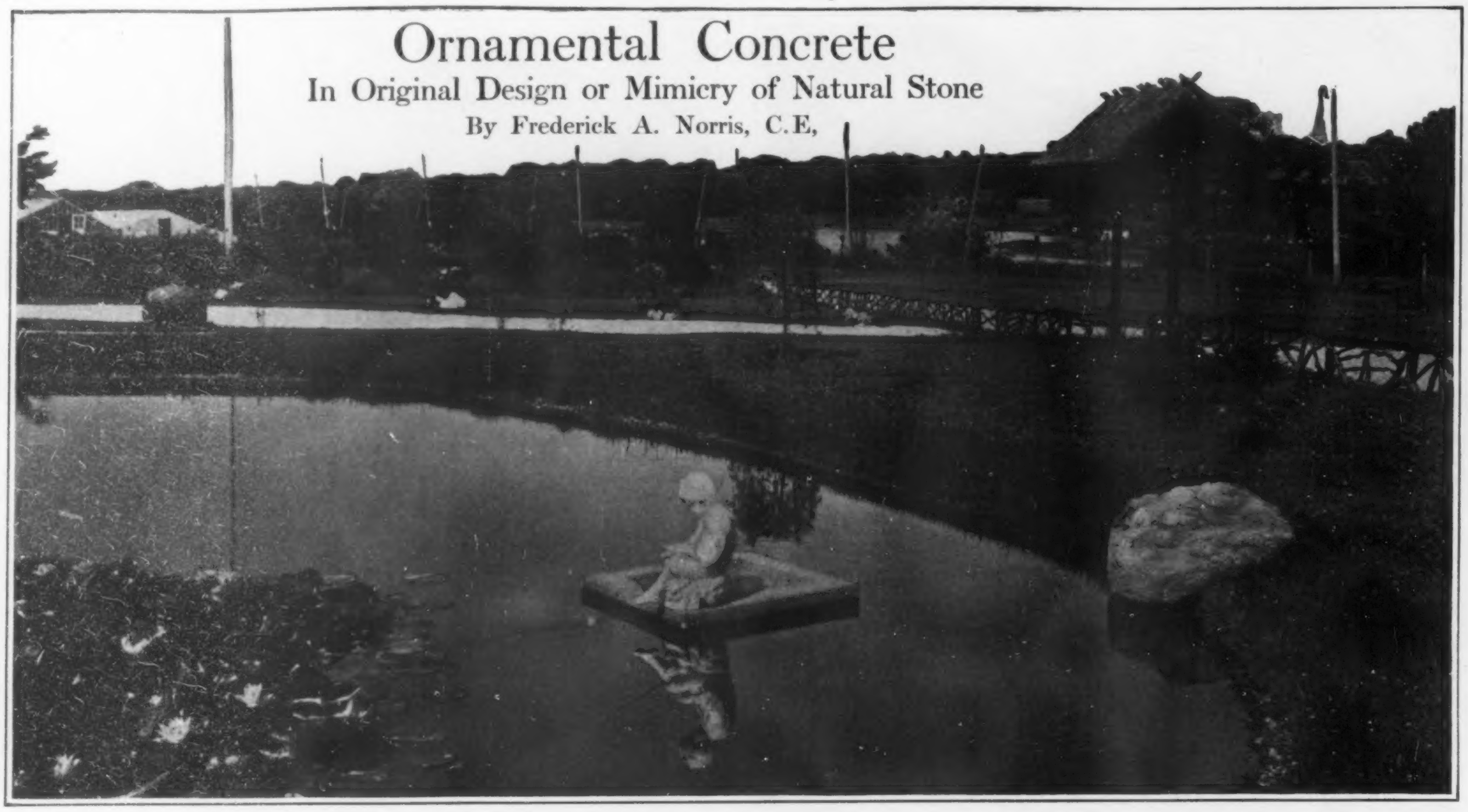
Progress of Marine Oil Engines

IN the annual report of *Lloyd's Register*, recently issued, reference is made to the use of internal combustion engines for marine purposes. With this type of engine there is considerable difficulty in effecting the reversal of the direction of rotation of the engine, and when these engines are used for marine purposes the astern motion of the screw has usually been obtained by the use of toothed wheel gearing. Comparatively recently there has been a development in the Diesel oil engine for marine work. A two-stroke cycle has been successfully adopted, and the reversal is effected in the engine itself, the crank shaft being directly coupled to the screw shaft. The Diesel oil engine is now being fitted to three fairly large vessels being built on the Continent under the supervision of the surveyors of *Lloyd's Register*. One set is being constructed on the older principle of the four-stroke cycle with single-acting cylinders, and will be of about 450 indicated horse-power. Another set is being made on the two-stroke cycle, also single-acting, and is intended for a twin-screw vessel, the power being about 900 indicated horse-power on each shaft. The third set is being made on the two-stroke cycle double-acting system, each cylinder providing two impulses per revolution; this also will be fitted in a twin-screw vessel, the total power being about 1,800 indicated horse-power. In each of these cases the engines will be directly coupled to the screw shafts. A set of internal combustion engines is being constructed under the society's survey in this country for a vessel of about 260 tons.

Ornamental Concrete

In Original Design or Mimicry of Natural Stone

By Frederick A. Norris, C.E,



CEMENT concrete has been used ornamentally only within the last fifty years, and only during the last twenty has it been used to any considerable extent. The dull gray textureless monotony of its surface prevented workers in it from realizing that it had large possibilities decoratively. Therefore, they confined its use to structural purposes and tried to conceal the material by facing it with stone, brick or plaster.

Since then it has been made in very large quantities for nearly all kinds of structures, but only very recently has it been used ornamentally with success, and have really pleasing effects of color and texture been produced. The statement can now be made positively that it is as good a material structurally as stone or brick, that it is generally cheaper and that it can be made just as pleasing to the eye as either, without imitation, but as a distinctive material suitable to use ornamentally in practically every place where the other materials are now employed. It can also, if desired, be made to look so much like quarried granite, limestone, or sandstone as to deceive even stone cutters.

Recently the writer was walking among the buildings of Harvard College at Cambridge with a very well known civil engineer, an authority on concrete—an expert. Our attention was attracted to some stone columns forming part of an ornamental gateway leading into the college grounds. My friend casually remarked in passing that the columns were an exceedingly fine imitation of natural limestone. I contradicted him with the statement that they actually were quarried stone and not concrete. This led to a careful examination of the columns, my expert taking out of his pocket a magnifying glass with which he more carefully observed. He then picked out a little piece of the material with his pen knife, and then again made the positive statement that the columns were made of concrete. As a matter of fact, they were Indiana limestone.

About a year ago one of the best known firms of architects in Boston was employed to draw up plans and specifications for an addition to a group of buildings also in Cambridge. The base-course steps and buttresses of one of these buildings were built of a stone very similar to Milford pink granite and the architects desired to use this same stone in the proposed new building. They made a careful examination of it, but failed to recognize it as having been taken from any local quarry, and as they did not know where to obtain it, they used Milford pink granite instead. As a matter of fact the stone was concrete.

Some manufacturers of ornamental concrete were requested by a large railroad corporation to see how near they could come to matching Chelmsford granite. The railroad had built some bridge piers of this stone which extended a few feet above the water line. Between these piers they planned to throw thirteen concrete arches with spans of about 150 feet each, and they wanted the arches themselves exclusive of the spandrels, the curbing balustrades and quoins, to match this Chelmsford granite. After some experimenting, a piece of concrete was produced and placed by the side of a piece of the natural granite. The chief engineer of the road, the president and the architects of the bridge, five men in all and all highly trained, examined the two stones at a distance away of from three to five feet and were asked to pick out the real from the artificial. Two of them were right in their guess, two of them wrong, and the fifth man declined to submit himself to the test. Now Chelmsford granite is one of the most beautiful building stones in America. It is light in color, but soft and mellow and warm. It gives the feeling of strength, durability and dignity, combined with modesty, for it is never garish or flaunting. University Hall at Harvard College, one of the most beautiful buildings in New England, was built of it by the celebrated colonial architect, Bulfinch. It would appear, therefore, that if concrete can be made to resemble this granite as closely as stated, concrete can be used to cover a much larger field ornamentally than heretofore, provided it is as good a material structurally in every sense, is economical, and last, but by no means least, that the uniformity of the product can be depended upon.

Two of the accompanying illustrations show how closely concrete can be made to resemble natural granite in appearance. They are views of the new addition to Gore Hall, the library building of Harvard College. The original building was faced with Quincy granite, and when the addition became necessary, the funds available were limited and the original granite had weathered, so that it would take some time before fresh granite from the same quarry would blend down to match it. The authorities, therefore, decided to use concrete provided the original stone could be matched in color and texture to make a harmonious whole. The result was successful. In the photograph the stone on the left is an actual granite, while that on the right is concrete.

In the new Hotel Kimball at Springfield, Mass., all the stone used is concrete, resembling in color and texture granite and Indiana limestone. The entrance to the hotel is shown herewith.

In the accompanying illustration of the church of St. Mary Immaculate of Lourdes, at Newton Upper Falls, Mass., all the stone work shown, including columns 32 feet high with their Corinthian capitals and even including the ornamental figures with dark red background in the tympanum, is of concrete. Attention is called to the undercutting of the capitals, which can be seen to best advantage on the one at the extreme left of the picture. In this climate it would be extremely dangerous to undercut natural stone capitals to this extent, as water would be apt to freeze in them and crack them off, but the headpieces being made of concrete, it was possible to overcome this objection by inserting steel reinforcement in each acanthus leaf, tying it into the bell; furthermore, natural stone columns like these are difficult to execute because a tangent to the upper curve of the leaf would lie in the plane of the natural bed of the stone, and therefore weaken the leaf at this point. The writer knows of no columns of quarried stone anywhere approaching this size in this climate so deeply undercut as these made of concrete, and the whole stone work of the exterior is the most ambitious, decoratively, that has ever successfully been attempted, to his knowledge, in this material.

Structurally, concrete has been proved and in this connection even has some advantages over quarried stone. It is more fire resisting, more water-proof than some of the most popular building stone, and much less subject to disintegration than some; besides it has the additional advantage of being free of laminations or seams and of being reinforced with steel, giving it greater strength in tension. This last advantage is important in the case of a stone used as a lintel over a doorway or window, or supporting a load over any opening, because if it should crack or shear on account of foundation settlement, the steel reinforcements would still be able to carry the tension. It must be understood that reference is made here only to good, properly made concrete.

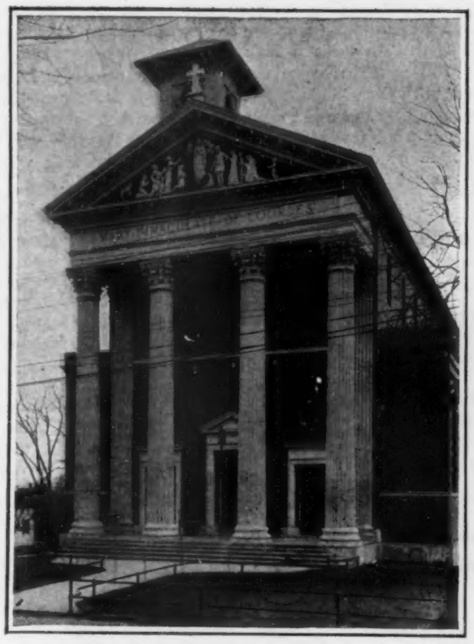
Whether the artificial stone is economical or not is largely a matter of location, but in most cases it is cheaper than natural stone where used ornamentally, especially if there is much duplication, and nearly always where used structurally on a large scale in place of stone masonry. There is a bank building in Bar Harbor, Maine, the ornamental trim on which is concrete stone made in Boston. The cement was shipped from Pennsylvania to Boston by rail, the concrete then made and finished, carted three miles to a boat and then taken to Bar Harbor over three hundred miles away and installed in the building which is located within two miles of a granite quarry. Under these seemingly adverse conditions as to location, the stone made by man was cheaper than a practically unlimited supply of that made by nature. There are a number of buildings in Maine, a State in which good granite is abundant, the stone trim on which was made in Boston and shipped hundreds of miles by rail to be used in place of the natural stone upon which the buildings themselves rest. This is a case of "carrying coals to Newcastle" with a vengeance.

On the other hand, the writer was called upon last summer to advise a man in reference to building a summer house on some rocks forming a point of land projecting into the ocean. The owner wanted the summer house built of concrete, while, as a matter of fact, as the work was rather complicated and the building small, it would have been much better looking, just as durable, and considerably cheaper had it been built of rubble masonry from stone easily obtainable on the site.

That the uniformity of the product cannot generally be depended upon is one of the great stumbling blocks in the path of progress in the use of concrete. Its proper manufacture requires trained, skilled men of brains under the most careful and painstaking supervision. This is contrary to the general belief of the layman, who is often under the impression that the finest and most uniform stone can be produced by simply mixing crushed stone, sand, cement and water in the proportions and in the way prescribed in some book on the subject, placing the mix in the form, and after it hardens, removing the form. Nothing could be further from the truth. There are no standards to go by. There are only principles. The crushed stone in one place is entirely different from that in another. Some of it breaks up cubically with sharp edges. Some of it shales; some of it powders; some of it has a smooth surface to which the cement will not bond well, and besides it varies in color. So it is with the sand and with the cement and even with the water. They all vary greatly in physical properties and therefore it takes an expert to decide properly which to use and which not to, and what proportions of each to use, in each particular case. There have been reams of articles written and no end of discussions over the amount of water to be added to obtain the best results. Too little water will not effect complete hydration of the cement; too much water will tend to destroy the homogeneity of the mass and cause the neat cement to be carried to the sides of the mold, leaving the aggregates in the center barren of binding material.

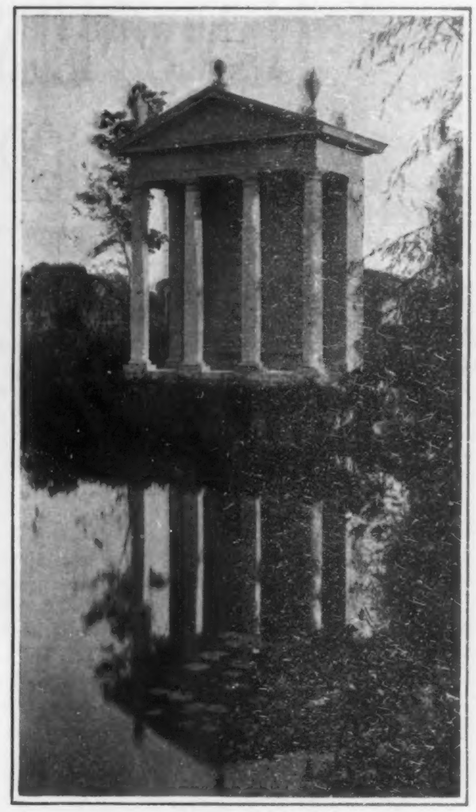
But without going into the matter any further, this it is hoped is sufficient demonstration of the importance of employing proper skill in the making, and is also a partial explanation of the reasons for so many failures and so much condemnation to which concrete has been subjected in its long uphill fight for the position

(Continued on page 293.)

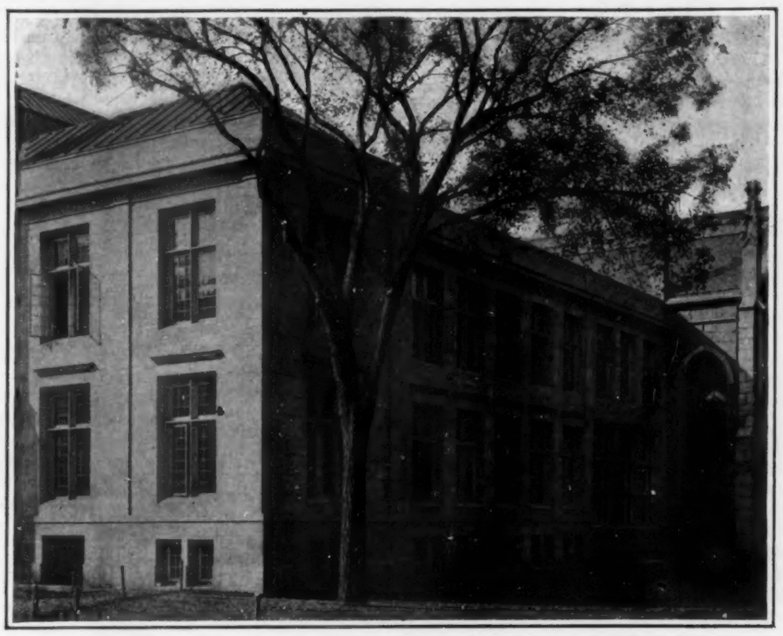


All the stone is concrete including figures of tympanum.

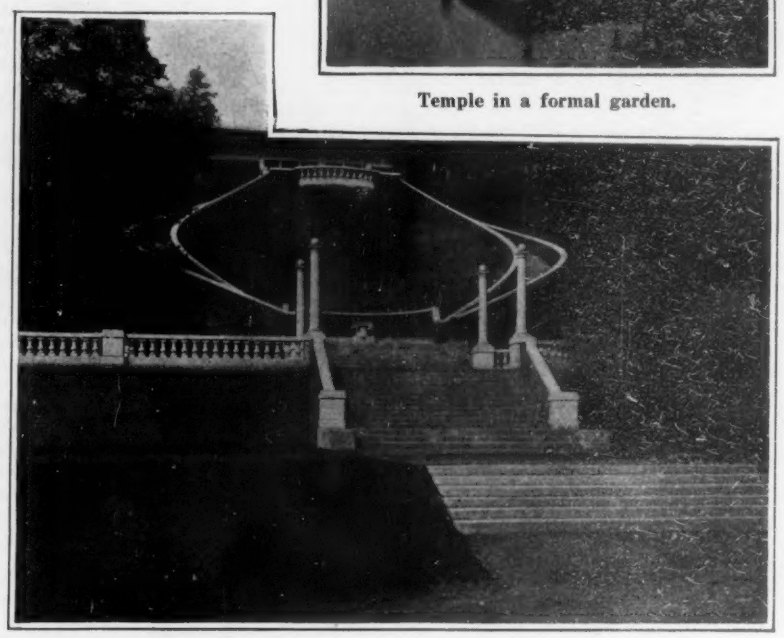
Concrete may be used to advantage in the conservatory.



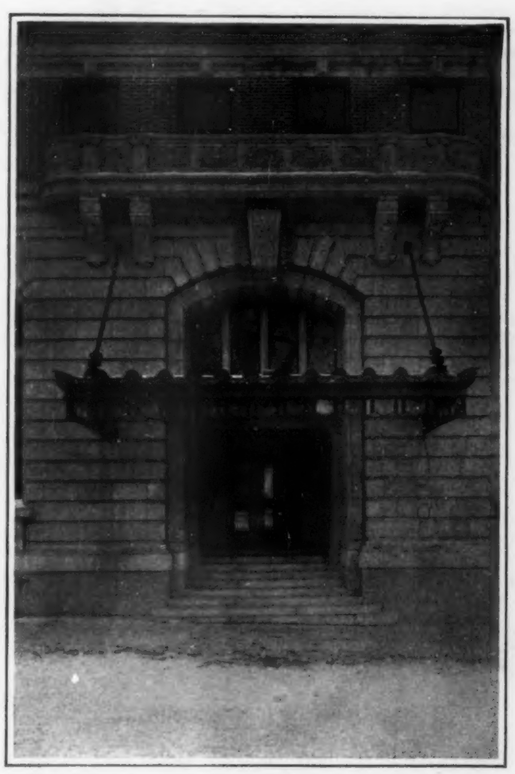
Temple in a formal garden.



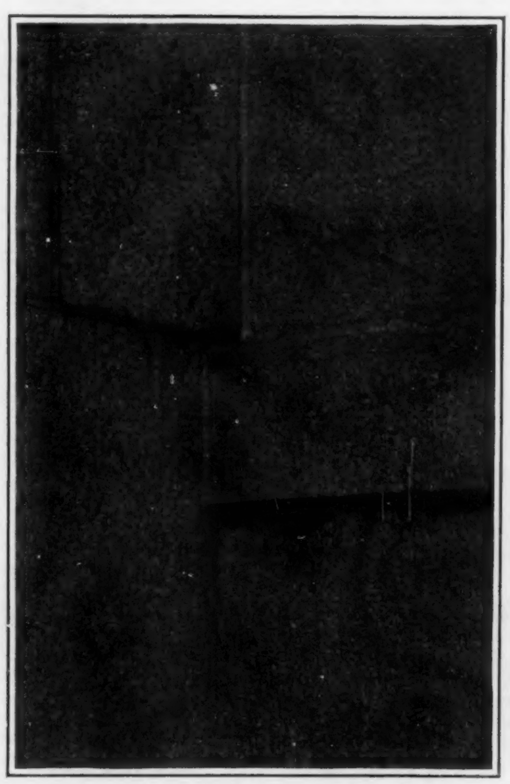
Addition to Gore Hall, library of Harvard College.



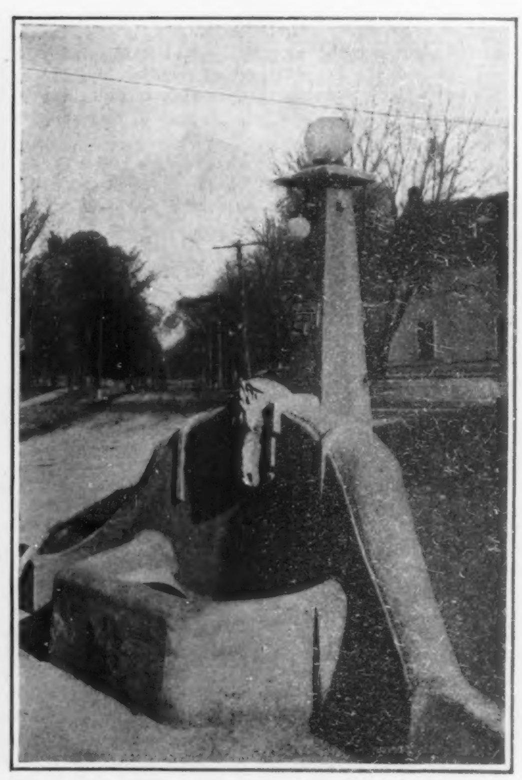
An imposing approach, showing the adaptability of cement.



Hotel entrance; all the stone is concrete.



On the left, Quincy granite; on the right, concrete.



Unique watering trough and lamp post.

SOME EXAMPLES OF ORNAMENTAL CONCRETE AND IMITATION STONE

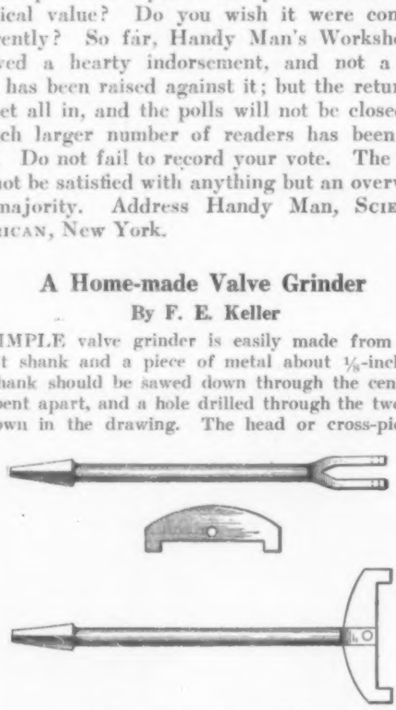
The Returns

THE response to the referendum made the week before last has been very gratifying. The Editor wished to know whether Handy Man's Workshop should occupy two valuable pages of the SCIENTIFIC AMERICAN every two weeks, or whether he should return to the old schedule of running the Department but once a month, and he put the following questions: Does Handy Man's Workshop interest you? Do you find it of real practical value? Do you wish it were conducted differently? So far, Handy Man's Workshop has received a hearty indorsement, and not a single voice has been raised against it; but the returns are not yet all in, and the polls will not be closed until a much larger number of readers has been heard from. Do not fail to record your vote. The Editor will not be satisfied with anything but an overwhelming majority. Address Handy Man, SCIENTIFIC AMERICAN, New York.

A Home-made Valve Grinder

By F. E. Keller

A SIMPLE valve grinder is easily made from an old bit shank and a piece of metal about 1/8-inch thick. The shank should be sawed down through the center, the ends bent apart, and a hole drilled through the two parts, as shown in the drawing. The head or cross-piece can

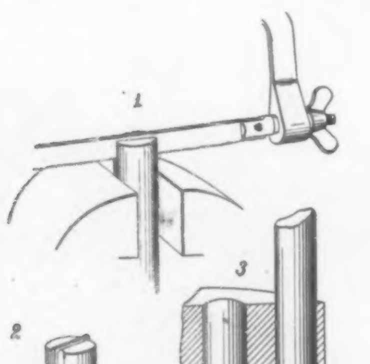


A home-made valve grinder.

be made of suitable size to fit the valve, with the hole drilled so that the joint will come as close to the valve as possible. Rivet the two parts together as indicated and you will have a handy tool to use in a brace. The valve receives the pressure in its true center, so that a very smooth cut is obtained.

Squaring the Bottom of a Drilled Hole

DRILLS are usually pointed and leave a conical depression at the bottom of the hole. To be sure, the point of the drill may be ground down, but this takes time and shortens the life of the tool considerably. If you have not a reamer of the proper size, the quickest

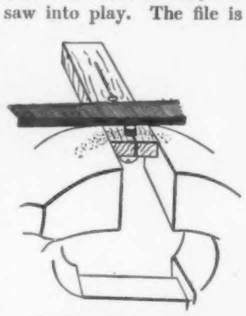


Hastily-constructed reamer.

and easiest plan is to take a round piece of machine steel that will just fit the hole that you have drilled, say three-eighths of an inch in diameter. Square off one end and with a thin hack saw make a saw cut in it, as in Fig. 1, to a depth of three-eighths of an inch. Then take a piece of ordinary clock spring and drive into the saw cut tightly. The clock spring should project from the end of the round steel about one-sixteenth of an inch, as in Fig. 2, when ground off. The sides might be left one-hundredth of an inch larger on the two sides to form cutting edges, if you desire to make the hole smooth along its walls. The clock spring steel will work in sizes up to three-quarters of an inch. A larger diameter would require thicker metal. A small nick can be filed along the sides of the reamer just in front of the cutting edges for clearance of chips. Fig. 3 shows the conical part of a drilled hole squared off at the bottom with the squaring-off tool in place.

Shortening Machine Screws

ON some work the workman is required to shorten quite a number of round-headed machine screws, but not enough to bring the hack saw into play. The file is the only tool. The round-headed screw does not hold well in the vise, as it easily tilts, thus bruising and marring the appearance of the head.



Shortening machine screws.

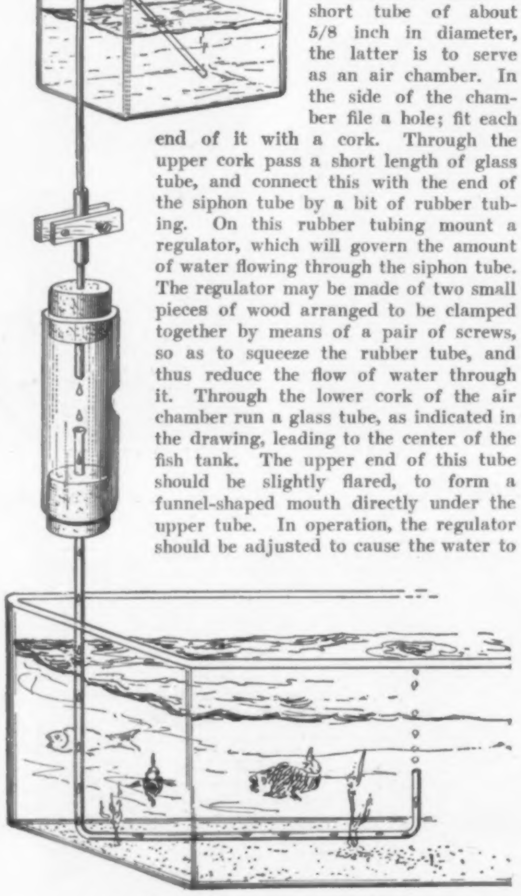
Take a piece of hard wood, making the right thickness for the length of the machine screw that you wish to file down. Drill a hole for receiving it, also saw a slit along the center of the piece of wood, as illustrated herewith. The machine screw is placed in the hole that is drilled in the wood. The wood is held in the vise, which pinches the screw tightly and secures it firmly, so that it may be filed.

The screws can all be filed to the same length without scratching the heads.

Aerating Apparatus for a Fish Tank

By John Y. Dunlop

A VERY simple device for driving air bubbles into a fish tank can be made as shown in the accompanying drawing. Place immediately above the fish tank a small reservoir. Procure a siphon tube 3/16 inch in diameter and a short tube of about 5/8 inch in diameter, the latter is to serve as an air chamber. In the side of the chamber file a hole; fit each end of it with a cork. Through the upper cork pass a short length of glass tube, and connect this with the end of the siphon tube by a bit of rubber tubing. On this rubber tubing mount a regulator, which will govern the amount of water flowing through the siphon tube. The regulator may be made of two small pieces of wood arranged to be clamped together by means of a pair of screws, so as to squeeze the rubber tube, and thus reduce the flow of water through it. Through the lower cork of the air chamber run a glass tube, as indicated in the drawing, leading to the center of the fish tank. The upper end of this tube should be slightly flared, to form a funnel-shaped mouth directly under the upper tube. In operation, the regulator should be adjusted to cause the water to



Aerating apparatus for a fish tank.

drip slowly from the siphon. The dropping water will fall into the mouth of the lower tube, and the air between each drop of water will be imprisoned within the tube. The alternate drops of water and air spaces will then travel through the tube to the fish tank, spreading through the water of the fish tank and thoroughly aerating it.

Shop Notes

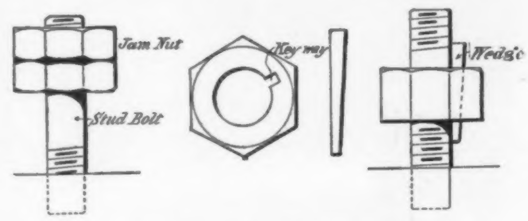
One Cause of Difficult Welding.—Has any mechanic ever tried to weld a stay-rod or some ordinary easy job, and found that the pieces simply flattened out without going together, just as though a thin film prevented the union? If so, he should have gone on a still hunt for some brother mechanic about the shop, and he would have probably found that this fellow had been heating his soldering copper at the forge. Such work puts a quietus on welding every time, until the coals are renewed from bottom to top. The trouble is easily remedied if the cause is known, otherwise it results in an exasperating loss of time.

Soldering a Radiator.—The removal of an automobile radiator to permit of soldering may be obviated by the following method, provided the leaks are not too numerous. The parts to be soldered will afford no difficulty to being well tinned with a hot iron, but solder in quantity sufficient to close a leak drops off or flows away. After tinning with the hot iron, allow the soldering iron to cool until it will just melt the solder, and then the solder can be "smeared" over the leak without dropping off. Small holes are easily "wiped" over in this way, or a piece of cardboard held close under the leak will retain enough solder to close the leak successfully.

Removing Stud-bolts Without an Alligator

By R. C. D.

STUD-BOLTS are often hard to remove, and when using an alligator wrench one is apt to cut them up pretty badly. Two methods of removing them, without injuring them in any way, are shown in the accompanying illustration. The first method, that of using a jam nut, may not be new to all, but the second method I have only seen used but once. It consists of a hexagon nut, the threads of which have been bored out, leaving a hole just



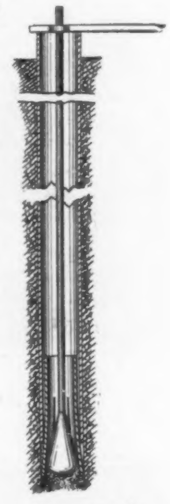
Two methods of fixing stud-bolts for easy removal.

large enough for the bolt, which is to be removed, to pass through it easily. A tapered slot or key-way is then cut in one side of the nut, as shown, and a wedge-shaped key of hard steel is made to fit snugly into it. This nut is then placed over the plain part of the stud-bolt, the key is driven home and grips the bolt firmly, thus when the wrench is applied it cannot slip and the bolt can be removed with but little or no disfiguration.

Handy Pipe-puller

By H. T. Peterson

IT often happens when driving a well that the pipe breaks, making it necessary to drive a new hole and to dig down for the point, as this part of the well-driving mechanism is expensive and worth recovering. Not long ago, in an emergency of this kind, it occurred to the writer to devise a simple pipe-puller. The device was constructed as shown in the accompanying engraving. A piece of 1½-inch pipe, 10 or 12 inches long, was procured, and four slots were cut in it for about half its length. Then a piece of round iron was secured, and formed into a wedge that would spread out the slit end of the pipe. This was made fast to a rod of sufficient length to run up to the top of the pipe which was to be pulled. The upper end of the rod was threaded to receive a handle, and by turning this handle on the rod, the wedge was drawn up, spreading the split pipe so that it jammed against the lower end of the pipe that was being driven, and thereafter the pipe was drawn up.

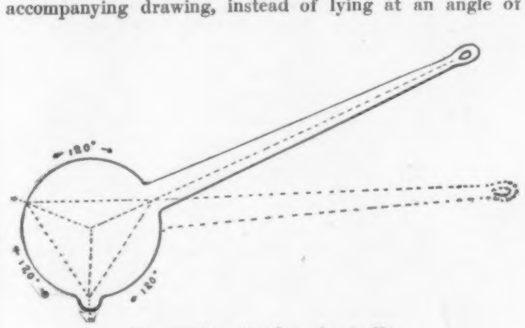


Home-made pipe-puller.

Suggestion for Foundry Ladles

By M. W. G.

EVERYONE who has watched the work in a foundry must have noticed the strain on the muscles of the men while trying to bring the ladle with its heavy contents to a sufficiently horizontal position to make the molten metal run out of the spout. If the spout were disposed at an angle of 120 degrees, the handle, as in the accompanying drawing, instead of lying at an angle of



Suggestion for foundry ladles.

90 degrees, as it generally does, the ladle could be discharged without any effort. Any one can verify this statement by filling a common saucepan to the brim with water, and then, while holding it by the handle in one hand, trying to pour the water out by the spout. It will be found far easier to let the water flow over the rim at about 120 degrees from the handle.

Science in the Current Periodicals

In this Department the Reader will find Brief Abstracts of Interesting Articles Appearing in Contemporary Periodicals at Home and Abroad

The Conquest of the Air by the Chemist

IN the editorial column of *Metallurgical and Chemical Engineering* the fixation of atmospheric nitrogen by electrical processes is made the subject of the following pointed comments:

"If we leave aside early and isolated experiments, the endeavor of the chemist to transform the inert elemental nitrogen in atmospheric air into some nitrogen compound of commercial value has extended on a systematic basis and on a relatively large scale over a little more than the last decade. The more we learn of the different processes—differing essentially in the type and design of the arc furnace employed—the more it appears that with respect to the yield of grammes of fixed nitrogen in form of HNO_3 per kilowatt-hour there is not much choice between them; little if any progress has been made in this respect over the unlucky Niagara Falls pioneer plant of Bradley and Lovejoy. Perhaps this is not so very astonishing since in the essential principle all the processes are alike.

"But progress has been made in raising the concentration of NO in the gas mixture which leaves the furnace, and very much progress in simplifying the design. Without making any invidious comparisons, the enormous advance made in simplifying the construction is evident; this must find its expression in dollars and cents in the first cost of the plant. How important this is for a new industry will be clear to anybody only slightly acquainted with the ways of capitalists, who are, after all, very human like the rest of us.

"With respect to the yield of fixed nitrogen per kilowatt-hour we may compare the nitrate process with the calcium cyanamide process, which, though essentially different, is also a method of atmospheric nitrogen fixation. If one kilowatt-hour produces 70 grammes HNO_3 it binds 16 grammes of nitrogen. On the other hand, in good commercial cyanamide practice one kilowatt-hour binds some 70 grammes of nitrogen in form of cyanamide. Naturally such a comparison, though interesting, is quite one sided.

"In a recent discussion before the New York section of the American Electrochemical Society Dr. M. Loeb pointed out that as the formation of NO from air at the temperatures of the arc represents equilibrium, the attempt should be made to remove the NO in some way from the air by absorption in some suitable body so that in order to re-establish equilibrium new NO would be formed, etc. Dr. Whitney pointed out that such absorption might be very difficult at the enormous temperature of the arc. Yet the principle is plausible. In Haber's synthesis of ammonia—another instance of fixation of atmospheric nitrogen—such absorption is carried out and makes the process really practical. But here we work in the cold and absorption is comparatively easy. Clearly, the whole subject is in a state of evolution. It was first vigorously attacked by electrochemists with their inborn insurgent spirit. It is now being taken up by conservative business men. Such a combination must prove invincible in the end."

A Demonstration of the Possibility of a Hygienic Milk Supply

MANY conditions injurious to the public health are still maintained through thoughtless adherence to traditional practices, but this evil will be gradually abated as the labors of the men who have devoted their energies to the promotion of hygiene become more widely known and appreciated. This result will probably be promoted by the International Hygiene Exhibition, which will soon be opened in Dresden, and at which, according to *Hygieia*, the official organ of the exhibition, the question of milk supply will receive consideration commensurate with its great importance.

This section will be especially interesting because it will show how well science and commercial industry can work together in this field and will demonstrate the practicability of a hygienic milk supply. It will contain a model laboratory equipped with apparatus for the practical application of methods which were recently confined to laboratories of research. The development of methods of examining milk is obviously of capital importance, for accurate and easily applied tests of milk for chemical composition, physical properties, alterations, adulterations and impurities of every sort are necessary to the establishment of rational and hygienic methods of milk production, supply and utilization, and to the formulation and enforcement of legal restrictions.

The bacteriological study of milk has revealed conditions of alarming import. It has long been known that the high death rate among infants in the first year of life is caused chiefly by bacterial infection, and it has been learned more recently that tuberculosis, typhoid fever and cholera, as well as the dreaded summer diarrhœa of children, are often propagated by impure milk and milk products. Through the carelessness of the rural population, especially, milk is often contaminated with the germs of both bovine and human diseases. The exceedingly complex constitution of the visible dirt so often found in milk will be fully illustrated at the exhibition.

The reform must commence on the farm as the evil wrought by uncleanliness in the stable and dairy can with difficulty be remedied. Hence hygienists demand the introduction of aseptic methods to an extent which appears excessive, at first glance, but which is so practicable that it is already in practice in many model dairy farms, as will be shown by instructive models and photographs.

Although it is impossible to exclude germs as completely in the dairy as in the operating room and the bacteriological laboratory, it is possible, even in small establishments, to maintain a standard of cleanliness which will entirely exclude visible dirt from the milk and will reduce bacterial contamination to a minimum.

These exhibits are designed especially to show what can be accomplished under the conditions of practice and to prove that hygienic reform rather increases than diminishes the profits of the milk business. The small farmer who keeps one or two cows will derive particular benefit from the exhibition of improvements, which have stood the test of experience, in stable construction and equipment.

There will also be an exhibition of sterilizing appliances and a demonstration of the alteration produced in milk by sterilization. Many of the germs in milk show astonishing vitality and resistance to bacterial agents, but radical and violent sterilizing processes generally injure the quality of the milk.

The problem is to avoid the evils flowing from this source, such as "Barlow's disease," caused by feeding infants with milk boiled too long, and yet to destroy the bacteria.

Finally there will be an exhibit of improved methods and appliances employed in making butter and cheese, and demonstrations of the nutritive and pecuniary value of these and other milk products, including the commonly underestimated skim milk. In this section it will be shown that although bacteria are generally injurious, certain bacteria are very useful in the production of kumyss, kefir and other valuable milk products.

Artificial Diamonds

THE fact that diamonds are simply crystallized carbon was discovered by Lavoisier and Sir Humphry Davy 150 years ago. Davy attempted to produce artificial diamonds by placing charcoal and graphite (which is another crystalline form of carbon) between the poles of powerful galvanic batteries, but obtained only fused masses of the silicates which the charcoal contained.

In 1839 Liebig wrote to Woehler that he had succeeded in making diamonds by crystallizing carbon from an aqueous solution, and promised to send Woehler an artificial diamond as thick as his thumb, but there is no record that the promise was kept. Liebig asserted that minute diamonds could be seen glistening in sunlight in common charcoal.

Other experimenters claimed to have produced diamonds by decomposing a solution of phosphorus in carbon disulphide and by heating charcoal in the electric arc, but these claims are merely examples of the mistakes which abound in the history of every science.

Artificial diamonds were, possibly, first produced in the seventies of the last century, by the English chemist Hannay, who obtained small crystals, said to possess the form and hardness of diamonds, by heating petroleum hydrocarbons and nitrogenous bone oil with metallic magnesium in sealed iron tubes. Marsden may also have obtained diamonds by heating silver inclosed in a mass of charcoal. Both of these claims, however, are disputed.

The first unquestionable success was obtained by the French chemist Henri Moissan by a very ingenious and rational process, based on a study of the conditions in which natural diamonds are found. Moissan's chemical researches had proved that diamonds often contain impurities, consisting chiefly of iron and silicon, and he discovered microscopic crystals, which he recognized as diamonds, in several meteorites, notably in one which fell in Devil's Gulch in Arizona.

Moissan conjectured that the great pressure produced in the interior of the meteorite by the formation of a solid crust, while the inner portion was still fused, had caused some of the carbon dissolved in the meteoric iron to be deposited in the crystalline form. In order to test this theory Moissan invented an electric furnace, consisting of a block of limestone, hollowed out for the reception of a crucible, and provided with two electrodes of carbon inserted through lateral orifices. The electric arc formed by these electrodes in the interior of the furnace produced a temperature of about 6,300 deg. F. Moissan employed a crucible of carbon, which was filled with a mixture of iron filings and pulverized charcoal. After the contents had been fused the crucible was cooled by immersing it in ice-cold water. This sudden chilling converted the iron in contact with the wall of the crucible into a solid crust, which imprisoned the hot and liquid mass within. As iron expands in solidifying, the gradual solidification of the interior mass, as it continued to cool, produced an enormous pressure. After the entire mass had become solid it was dissolved in acid. The undissolved residue was found to contain minute diamonds, the largest of which had a diameter of 1/36 inch.

Fisher modified Moissan's apparatus by placing beneath the furnace a vessel of water into which the crucible could be instantly dropped. This increased the suddenness of chilling, which is a very important factor in the process.

An article in the *Technische Monatshefte*, from which these facts are gleaned, adds that Friedlaender and Von Hasslinger have come to the conclusion that a genetic connection must exist between diamonds and the rock in which they are found. These chemists succeeded in producing microscopic diamonds, 1/25000 inch in diameter, by fusing olivine with charcoal. By substituting artificial olivine for the natural mineral and effecting the fusion with the aid of thermite, they obtained larger crystals. None of these artificial diamonds, however, exceeded 1/500 inch in diameter, so that this process, like Moissan's, possesses no practical value.

Sir William Crookes, in experiments on the explosion of cordite in closed vessels, in which a pressure of 8,000 atmospheres and a temperature of 9,750 deg. F. were attained, found minute crystals of carbon in the residue left by the cordite.

These are the simple facts in regard to the artificial production of diamonds. The problem was solved theoretically by Moissan, but it has not yet been solved practically, because the diamonds produced are too small to have an appreciable commercial value.

Pragmatism in Science

IN a recent number of *Science* Prof. Sedgwick Minot refers as follows to some of the metaphysical questions which arise with regard to the fundamental assumptions of science:

"Scientific men base their work upon a series of assumptions: first, that there is absolute truth, which includes everything we know or shall know; second, that we ourselves are included in this absolute truth; third, that objective existence is real; fourth, that our sensory perception of the objective is different from the reality. These conceptions constitute our fundamental maxims, and even when not definitely put in words they guide all sound scientific research. Metaphysicians find such maxims interestingly debatable, but science applies them unhesitatingly and is satisfied because their application succeeds. Philosophy, ever a laggard and a follower after her swifter sister, has lately and somewhat suddenly termed the scientific habit of work pragmatism and has taken up the discussion of it with delightful liveliness. Let us acknowledge the belated compliment and continue on our way.

"The practical result of the four maxims has been that we further assume that all errors are of individual human origin and that there are no objective errors. We make *all* the mistakes, nature makes none. To render the pursuit of new knowledge successful our basic task is to eliminate error, or in other words to decide when we have sufficient proof. The elimination of error depends primarily upon insight into the sources of error, which, since methods of all sorts are employed, involves an intimate technical acquaintance with the methods, with just what they can show, with what they cannot show and with the misleading results they may produce. In the laboratory training of a young scientific man, one chief endeavor must always be to familiarize him with the good and the bad of the special methods of his branch of science. Not until he thoroughly understands the character and extent of both the probable and the possible errors is he qualified to begin independent work. His understanding must comprise the three sources of observational error, namely, the variation of the phenomena, the imperfections of the methods and the inaccuracy of the observer. The personal equation always exists, although it can be quantitatively stated only in a small minority of cases.

"We think of science as a vast series of approximations and our task is constantly to render our approximations closer to absolute truth, the existence of which we take for granted. We use our approximations as best we may, treating them in large part and at least for the time being as if they were accurately true, yet meanwhile we remain alert to better them. This has long been the standard of scientific thought. It is the pragmatic attitude of mind, but its new name has not rendered it a novelty."

A Ticket-making Machine

ACCORDING to the *Engineering News* a ticket-making machine has recently been installed by the Long Island Railroad Company at its Flatbush Avenue station in Brooklyn, N. Y. The machine was manufactured in France, where a number are said to be in service, and is the first one of its kind to be used in America. By its use the ticket agent can in a few seconds make a ticket between the issuing station and any other point on the division. Besides the two stations the ticket also has the date of issue, the purchase price, and a number, dependent upon the class and destination. Four classes of tickets may be issued, whole fare one way or excursion and half fare one way or excursion. Besides the ticket the machine also prints two paper record slips for the use of the auditing department and acts as a cash register by recording the total sales. The stations and kind of tickets are indicated on dials on top of the machine. These are set by the operator, who pushes a lever which brings the plates into position, a small electric motor then completes the operation. It is said that the machine is so satisfactory that others will be installed.

The Inventor's Department

Simple Patent Law; Patent Office News; Inventions New and Interesting

Unsinkable Fishing and Life-saving Boat

IT IS NOW some nine years since the Anthony Pollack prize for life saving apparatus was offered, but hitherto no award has been made, although many competitors have submitted various devices in claim of this prize. None of the inventions submitted were deemed worthy of the recompense by the judges. The reason for this no doubt lies very largely in the fact that it requires an experienced naval engineer to design a boat which satisfies the very rigorous conditions laid upon the craft designed for these very special purposes. An attempt to solve the problem, which appears to present some special merits, has recently been put forward by M. Pitre. It is designed to fulfill a double function, namely, in the first place to serve as a life boat, and secondly, to take the place of the ordinary fishing boats in use in France and other countries. These boats are of very light build, pointed fore and aft, and in them the fishermen carry on all the operations which are not performed on board the vessel. The present form of fishermen's boat appears to be imported from Canada, for it is very much in use in the Newfoundland regions, where each vessel is equipped with a number of these boats. The crew use them for taking out the nets and for raising the draft, and often go out quite a distance from the vessel. The use of these boats unavoidably claims a high toll of accidents, as they are very unstable and difficult to handle. It is a frequent occurrence for the crew to be lost in the fog and to drift around for many days, unable to rejoin their vessel, and exposed to death from the waves or by exhaustion and hunger. The reason that this old type of boat is still used in spite of its many disadvantages and perils, is its simple construction and small cost. It is a flat-bottomed boat resembling somewhat the Chinese sampan, and its form is convenient in that a number of such boats can be stacked up one over the other, a pile of six boats occupying but very little space on board the vessel.

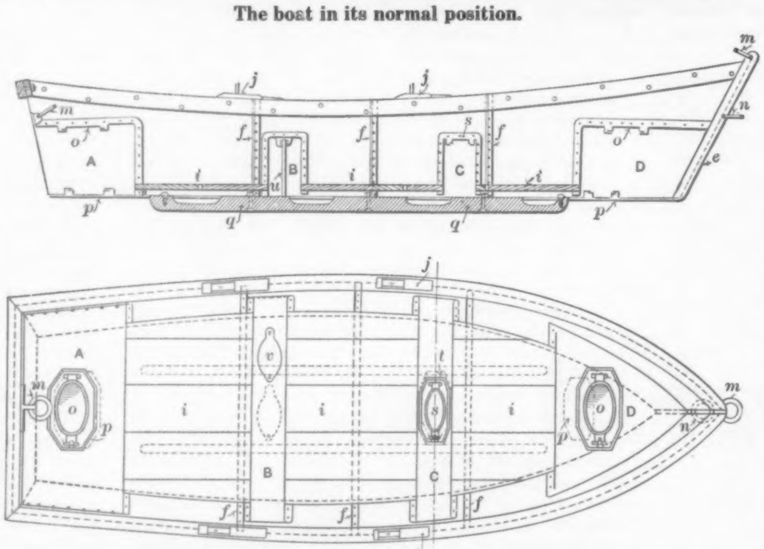
The endeavor has been made to replace these boats by some safer type. With this end in view M. Pitre has adopted a shape essentially similar to that to which the fishermen are accustomed, in the hope that they may be the more readily induced to adopt the new model, even though a somewhat greater expense is incurred by thus following the old form. At the same time the boat is designed distinctly as a life boat, and with a view to competing for the Anthony Pollack prize a description has been duly filed at the National Arts and Crafts Institution of Paris. The new boat is built of steel and conforms in general to the French regulations relating to the design of life boats. It has a capacity of 105 cubic feet. At each end are water-tight compartments *A* and *D*, which render the boat unsinkable. There are also two intermediate water-tight compartments *B* and *C*, which serve at the same time as seats for the oarsmen. Each compartment has a porthole closed with a water-tight cover. The compartment *B* is used to store drinking water. In the same way compartment *C* holds the solid provisions for the men, and as the crew is small sufficient can be carried to last for quite a number of days. In the ends of the boat extra changes of clothes are stored in a dry place. One of the special points considered in the design of the boat is the possibility of its capsizing. In such an event a good hold is presented to the hands of the crew by two parallel keels running along the bottom of the boat, and as the boat is quite flat-bottomed, the crew can remain in this position without serious discomfort for quite a while, provided they have a good supply of food.

In order to insure this an ingenious arrangement enables them to gain access to the food, there being a set of portholes in the bottom of the boat, communicating with the four compartments in about the same way as the portholes on the upper side of the boat. Thus food, water, and clothing can be drawn from the boat as occasion arises. One of our engravings shows the men supporting themselves upon the bottom of the upturned boat. The design of M. Pitre's boat appears to be very practical, rendering it thoroughly adapted both for general use for fishermen, and also for life saving purposes. It has successfully passed through a number of tests both at sea and in the river. Our views were taken on the River Seine.

The new and the old form of boat, showing the general similarity of the two.

The old form of boat when capsized would support only one man.

The boat in its normal position.



Longitudinal section and plan view of the new boat, showing the watertight air compartments A, B, C, D.

View of the capsized boat, exposing the portholes through which access is gained to the food and water.

The boat capsized and the crew of four supported on the upturned bottom.

UNSINKABLE FISHING AND LIFE-SAVING BOAT

Death of William L. Aughinbaugh

THE death of William Larimer Aughinbaugh, former Principal Examiner of the United States Patent Office, took place at Monrovia, California, February 17th, 1911, to which town he came in hopes of regaining his health after resigning from the government service over four years ago.

Mr. Aughinbaugh was born in Shippensbrug, Pa., April 26th, 1846, and learned the printing business. A mere boy at the outbreak of the Civil War, he enlisted at Cincinnati, Ohio, in Company E of the Fifth Ohio Volunteer Infantry, and was afterward transferred to Company I of the same regiment, being honorably discharged from the army June 13th, 1865, at the close of hostilities. He was wounded at the battle of Chancellorsville, and afterward taken prisoner and confined in Libby Prison. In company with his regiment he was sent from Alexandria, Va., to New York city to suppress the draft riots. After his discharge from the army he went to work on the Cincinnati *Enquirer*, and later came to Washington as an employee of the government printing office. He took the Civil Service examination and was appointed to the Patent Office, where he served thirty years, three as law clerk and sixteen as Principal Examiner. Being a graduate of law, he was also a member of the district bar, as well as the bar of the Supreme Court of the United States.

Brief Notes Concerning Inventions

Patents at Sea.—While, ordinarily, United States patents extend only throughout territory under the jurisdiction of the United States, they have a further force in that they extend to United States ships to the same extent when they are on the high seas as if they were solid on United States territory. Also the manufacture or sale of a patented article on board a foreign ship while in a United States port would infringe a patent for such article, although the mere use of the article on such foreign ship would not likely constitute an infringement of the patent rights.

The Stupendous Value of Trade-mark Rights.—The attorney for a large northwestern milling corporation told the writer his company would spend millions in defending its trade-marks; the manager of a patent medicine concern, based on a trade-mark and capitalized for less than $25,000, said his company spent $1,000 per day advertising, and the attorney of another patent medicine company whose trade-mark is known in practically every household, stated that the output of his company was five car loads per day and was worth $16,000 per car load, a total of $80,000 per day. Yet we find many manufacturers who advertise widely, foolish enough not to avail themselves of the present highly favorable trade-mark law, which reduces the expense of litigation and gives other advantages.

As Others See Us.—He is an assistant examiner in the Patent Office, and at the time of the story was examining the official class of "Brushing and Scrubbing." His small daughter, one day, was in the company of a number of other little girls who were telling where their respective fathers worked. When it came her turn she said: "My father does brushing and scrubbing down at the Patent Office."

LEGAL NOTICES

Classified Advertisements

Advertising in this column is 75 cents a line. No less than four nor more than 12 lines accepted. Count seven words to the line. All orders must be accompanied by a remittance. Further information sent on request.

READ THIS COLUMN CAREFULLY.—You will find inquiries for certain classes of articles numbered in consecutive order. If you manufacture these goods write us at once and we will send you the name and address of the party desiring the information. There is no charge for this service. **In every case it is necessary to give the number of the inquiry.** Where manufacturers do not respond promptly the inquiry **may** be repeated.

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BASIC INVENTIONS WANTED.—I will consider the purchase of one or more inventions, broadly protected by patents allowed or applications on which broad claims have been granted. Only inventions with broad commercial possibilities will be considered and preference will be given to inventions relating to the paint and varnish or paint specialty trades. Give full description. J. P. F., P.O Box 40, Bayside, Long Island, N.Y.

FOR SALE.

MANUFACTURING BUSINESS—Outright or part; Presses and special machinery; established trade with best concerns in U. S. Reason, sickness. B. L. Wright, 212 East 56th Street, Chicago, Illinois.

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WANTED.

LOCAL REPRESENTATIVE WANTED.—Splendid income assured right man to act as our representative after learning our business thoroughly by mail. Former experience unnecessary. All we require is honesty, ability, ambition and willingness to learn a lucrative business. No soliciting or traveling. This is an exceptional opportunity for a man in your section to get into a big-paying business without capital and become independent for life. Write at once for full particulars. Address E. R. Marden, Pres. The National Co-operative Real Estate Company, L 378 Marden Building, Washington, D. C.

WANTED. A partner with sufficient money. Patent No. 908,379, whereby an engineer can open and close his own switch, from the moving train, by electricity.
W. F. Bath, Bisbee, Arizona.

WANTED a manufacturer, for my newly patented ten pin toy alley. For particulars see this paper, next column. Address: Geo. A. Wehner, Savannah, Ga., 420 Habersham Street.

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Inquiry No. 9218.—Wanted, the names and addresses of manufacturers of outfits for salting almonds and peanuts.

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Inquiry No. 9228.—Wanted, to buy fabric tufting machines.

Inquiry No. 9229.—Wanted, addresses of manufacturers of an alloy called Duraluminum.

Inquiry No. 9231.—Wanted, addresses of owners of water falls having a four-foot fall and upwards.

Inquiry No. 9232.—Wanted, addresses of manufacturers of engines that can be run with crude oil.

Inquiry No. 9233. Wanted, a roller or other device for skinning a beef in rapid, economical manner.

Inquiry No 9234. Wanted a small specialty of universal salability to sell from $3 to $10. Proper articles can be financed.

RECENTLY PATENTED INVENTIONS.

These columns are open to all patentees. The notices are inserted by special arrangement with the inventors. Terms on application to the Advertising Department of the SCIENTIFIC AMERICAN.

The weekly *Index of Patents* issued by the *United States Patent Office* will be found in the *Scientific American Supplement*.

Pertaining to Apparel.

ARCH SUPPORT.—L. DURIEU, New York, N. Y. The object here is to provide a support for boots and shoes arranged to permit of conveniently placing it with a view to properly support the arch of the foot without producing discomfort while walking or resting. Use is made of a pocket having a heel extension and a sustaining plate within the pocket and having a convex top, and a flexible terminal at the inner side capable of following the instep portion of the shoe upper.

Electrical Devices.

TELEPHONE MOUTHPIECE.—LOUIS STEINBERGER, Brooklyn, New York, N. Y. This invention has for its more particular purpose the improvement of the sanitation of the mouthpiece, and also to provide for increasing its strength for rendering its various portions readily accessible and for otherwise improving its general efficiency. The device is of such form as to provide a surface comparatively free from lodging places for bacteria and other disease germs. The complete structure enjoys a minimum of abrupt corners, and the material used in the mouthpiece insures perfect bracing strength.

CONTACT FOR INDUCTION COILS.—J. MCINTYRE, Jersey City, N. J. The intention here is to provide a contact for induction coils and like electrical apparatus, arranged for attachment to or removal from a carrier, to allow convenient and quick replacing of the worn out or used up contact by a new one and without disturbing any part of the apparatus.

Of Interest to Farmers.

PLANTER.—G. F. W. HARRIS, JR., Bunker Hill, Ill. The purpose of this inventor is to provide a simple and inexpensive device, adapted for attachment to the leg of any planter, to take the place of the usual runner, and which will cut a smooth and uniform trench to receive the same and will cover the seed after it is planted.

MARKER ATTACHMENT.—L. R. TURNER, Long Pine, Neb. This attachment is operable by the driving axle or other driving mechanism of the planter, by means of which the marker for indicating the positions to be occupied by rows of plants or hills, can be automatically disposed into a plurality of positions operative and inoperative, in which the construction is simplified by the reduction of the number of parts, and in which the marker is jointed, to eliminate the possibility of injury to the arm should the line attached thereto and holding it in position be broken.

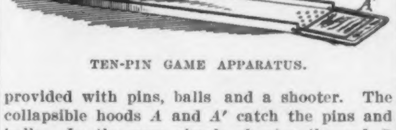
Hardware and Tools.

RESILIENT COMPOUND LEVER.—W. V. GILBERT, Kings Chambers, London, England. This invention relates to levers formed of spring material and having lever arms, and a back part connecting the lever arms and being so constructed that when the back part is subjected to lateral compression applied to its ends the said arms are caused to move in another direction, that is to say, approach each other at their free ends, and when such part is released from pressure, the device resumes, or springs back to its normal form.

Pertaining to Recreation.

AERIAL TOY.—F. A. TERRY, San Francisco, Cal. In the present patent the invention includes means for suspending a parachute or other object from a string or wire that may be connected with a kite, and for automatically releasing such parachute or other object upon reaching the proximity of the kite. It is designed to form a highly amusing toy.

GAME APPARATUS.—GEORGE A. WEHNER, 420 Habersham Street, Savannah, Ga. The aim of this invention is to provide a device which may be used as a parlor entertainment. At this ten pin board shown in the engraving, the players sit opposite each other and are



TEN-PIN GAME APPARATUS.

provided with pins, balls and a shooter. The collapsible hoods A and A' catch the pins and balls. In the very simple shooter the rod R is pulled back. A slight pressure at P will release it and send forth the ball with the accuracy of a billard cue. All games practised on the usual bowling alley can be played on this board.

NOTE.—Copies of any of these patents will be furnished by the SCIENTIFIC AMERICAN for ten cents each. Please state the name of the patentee, title of the invention, and date of this paper.

The Problem of Waterproofing

(Continued from page 273.)

A number of special coatings for cement have recently been placed on the market, the makers of which all claim that they will successfully withstand the action of the alkali in the cement. It is the action of the alkali in the cement which causes the destruction of an ordinary linseed oil paint, especially when applied to a new concrete surface. The waterproofing qualities of a number of these special cement coatings are in many cases greatly overdrawn. Therefore, in selecting a paint the purchaser will do well to test it for himself. The simplest way to do this is to procure a fairly porous brick and give it as many coats of paint as are intended to be given to the wall which is to be painted. (Two coats are always better than one, especially if a light color is to be used.)

After the coating on the test brick is thoroughly dry, have it weighed and make a note of the exact weight. Then put the brick in a pan or pail, in which there is just enough water to completely cover it. Allow it to remain submerged for at least twelve hours, and then remove it and after wiping off all of the surface water again weigh it, and compare its weight with the weight before it was submerged. The difference in weight will show just how much water went through the coating and was absorbed by the brick. Make a number of tests as described above with various paints, keeping careful notes of all results. The paint which shows the greatest water resisting qualities will be the one to use. In making the above tests be sure to see that the bricks are thoroughly coated, and that plenty of time is given for the paint to cure or harden before they are submerged in the water. Aside from the colored coatings mentioned above there are a large number of so-called colorless waterproof coatings on the market.

These are intended for use where one wishes to retain the natural color of the concrete. They are also largely used as a preservative for limestone, sandstone, etc. Probably one of the oldest materials used for this purpose is the ordinary commercial paraffine. This is applied to the surface hot with a brush. Then the surface thus treated is subjected to heat, which opens the pores in the stone or cement, and allows the paraffine to enter into all of the small crevices and voids, thus sealing them up and preventing any further moisture from entering into the mass.

All the commercial waterproofing preparations depend for their action on the principle of penetrating into the mass and filling up the voids. Most of them are sold in liquid form, gasoline being used as the solvent and saturant. Care must be taken in using materials of the above nature, as the majority of them accomplish their object by the incorporation of wax and grease. Therefore, if they are used to excess a most objectionable greasy and glossy appearance will be given to the surface. This is especially true if they are used when the weather is at all cold.

Aside from keeping the dampness from penetrating through the concrete, a good waterproofing will also help materially in preserving the surface from deterioration caused by the elements. Every one who has paid any attention at all to concrete has noticed the small cracks which appear on its surface. Waterproofing the surface will to a large extent prevent these cracks, as in many cases they are caused by dampness penetrating through the surface and then freezing. It is especially important to waterproof the surface of cement stucco which is applied on metal lath. For if this is not done, the moisture will penetrate through the cement and attack the metal, thus causing it to rust out and decay. The integral method of waterproofing is often used for stucco work. This has proved very successful in many instances. Care must be taken, however, to see that the hydrated lime or other compounds or liquid preparations which may be used are thoroughly incorporated throughout the mortar.

The waterproofing of concrete roofs is accomplished in a manner similar to that used for roofs which are made of other materials. Any of the good ready roofing materials may be used, laid as recommended by their makers. Tar and felt, as well as asphalt and felt, are also used extensively.

One of the principal things to care for is to see that ample flashings and counter-flashings are provided for around all projecting parts, such as parapet walls, skylights, ventilators and chimneys.

In Fig. 3 is shown the proper method of arrangement for the flashing and counter-flashing. The flashing is shown at *a* and it should be turned up against the parapet wall for a distance of at least eight to ten inches. The counter-flashing, which preferably is of metal, should project into the wall as shown at *b*. It should start at about twelve inches from the surface of the roof and should be allowed to project over the flashing to within about two inches from the surface of the roof. The inner section of the parapet wall above the flashing should be given a good coat of waterproof paint, so as to protect it from the weather. This is important, for if not done, water will get in and percolate down through the wall. If the parapet wall is not too high the counter-flashing can start from under the coping as shown at *A*, Fig. 3, in which case the waterproof coating may be omitted.

Very often, in new work, the waterproofing course is extended through the entire thickness of the parapet wall, as shown in Fig. 3 at *B*. This eliminates any trouble that might arise from leakage due to moisture coming in above the flashing, or from any water that might get into the wall through the joints in the coping.

Aside from the roofing materials mentioned above, there are plastic roofing compositions which have given excellent results. These are applied with a trowel like mortar and are more or less elastic in their nature, and thus allow for a certain amount of expansion and contraction. Aside from their being waterproof they are fireproof as well, but as in the majority of ready-roofing materials the ingredient used in their composition is held as a secret.

For the waterproofing of concrete swimming pools, tanks, etc., a course of tar and felt or asphalt and felt may be employed, using the same general methods for application as described for the waterproofing of foundations. If the tanks are well reinforced, so as to provide against expansion cracks, and a good rich mixture of concrete is used, the integral method of waterproofing, however, will produce good results.

If leaks should develop owing to small expansion cracks, they can be completely sealed up by a liberal coat of asphaltic paint applied to the inside of the tank. Another method employed is to build the tank with a more or less lean mixture of concrete and, when this is completed, to apply to the inside surface of the walls a good rich cement mortar troweled hard and smooth. Many incorporate into this coat one or the other of the many liquid or powder forms of waterproofing compounds. This method has proved most successful, not only for tanks, but also for the repairing of leaky cellar walls and floors. In waterproofing, always remember that the waterproofing, no matter of what material, should always be applied to side of the walls nearest the source whence the water comes. This in foundation walls is generally from the outside, and in tanks is always on the inside of the walls.

In conclusion, it should be said that weather conditions, as well as thorough workmanship, have much to do with the final efficiency of waterproofing. Better results can always be obtained in warm weather than in cold. So bearing this fact in mind, never have waterproofing applied in winter time, unless it is absolutely essential.

The Cement Market

(*Continued from page 278.*)

blast furnaces. This was in 1901, in which year a process was discovered for making of this material a very good grade of Portland cement. It could be produced cheaper than the regular product, and the younger company was able to come into the market below its competitors. In 1901 this company turned out 200,000 barrels of Portland cement. Last year its output was 7,000,000 barrels. The addition of new machinery now being installed will enable this company to turn out 10,000,000 barrels this year, and by 1912 its annual output will have reached 12,000,000 barrels.

This competitor had for its field the entire Middle West. Peace reigned as long as the eastern companies kept out of that field. Finally trouble began to brew. Eastern companies could not logically enter the western field. Freight rates would not permit it except at a loss. But Atlantic coast cement did go into that territory, and it was not long before the young giant was forcing its ways into the eastern market.

Prices were slashed right and left after

that, and the result was a combination of eastern manufacturers who decided to keep their territory to themselves and to discipline the minor companies who had stirred up the trouble. So the Association of Licensed Portland Cement Manufacturers was organized in the financial section of New York, and it planned to remedy existing conditions. Some companies who had very advantageous locations regarding factory site and freight rates to the neighborhood of New York State dam construction and water works developments refused to enter the association, although they gave their moral support to the movement. Others would not join because competitors did not. About a dozen companies went in, however, and they were pledged to hold together until February 1st, 1911, but the association disbanded on the thirty-first day of December, thirty days prior to the time it was scheduled to expire.

Prices immediately fluctuated. First they were cut, then they were advanced ten cents a barrel, and finally about the end of January they held firmly. Indications now point to a firm hand keeping the refractory companies in line so as to prevent them from plunging themselves into the abyss of failure. One factor in the early disbanding of this association was an adverse decision in the courts affecting the Hurry and Seaman patents under which there was an attempt made to claim that practically no natural Portland cement is made in this country. This case is still pending, and a final decision will help to clear the atmosphere in the whole trade.

During this period the cement companies were hard pushed to find profitable business. The Panama Canal work and the Ashokan and Catskill dams, the Seaboard Air Line's railway over the Gulf from the Florida mainland to Key West, all took large quantities, but the great need was for a steady outlet taking small quantities at a time, but large quantities in the aggregate of a year's business.

The secret of success in the Portland cement industry is to keep the entire equipment busy to its full capacity. This reduces cost of manufacture. The question then arose, "How shall we get this small business?"

It is a far cry from a sale totalling 2,000,000 barrels to the sale of a 100-pound bag of cement, but the manufacturer is just as keen after the latter as he is for the former. To this business instinct of the cement producers must be largely ascribed the credit of having created the improved American farm. Here, then, is the required new outlet. It works out about this way:

The farm used to be a delapidated place. Any old thing would do; a stick for a fence post, boughs for a culvert bridge, an old tin roof for a pigsty and a shed for a cow barn. The farmer himself lived in a shanty, or a house without comforts, cold in winter and baking hot in summer. The cultivator of the soil spent most of his winter days whittling clothespins at the country store and idly gossiping about his neighbors.

To-day he reads in the free book of how cement may be used on the farm. He is convinced and orders a bag of cement from the general store in his town. He decides he will try the experiment of making a concrete fence post. He follows the rules in his book and he discovers how easy it is. Besides, he argues, "It puts my winter days to good use." Then he buys a barrel to build a ratproof corn crib and discovers how easy and how cheap the new-fangled idea is. Discharged farm hands cannot burn down his barns at night because they are fireproof. Sanitary concrete cow sheds make healthier cows that fetch more on the market. His loss from mouldy oats and wheat are diminished or eliminated, with accompanying gain to the health of the horses. He preserves his decaying shade trees by the use of cement filling. The warmth afforded his chickens in their new concrete hen houses insures winter eggs, and soon he can afford a fine automobile for that concrete garage he has been planning as a sort of farm luxury. His children can be taken ten miles to the nearest town to school, instead of going to the district school, and when they come home they walk from the front gate to the front door on a snowy white concrete walk and not through mud ankle deep. The manufacturer comes in for his profit in thus helping the farmer, by selling fifty carloads of cement to a small, isolated country town in a single season, whereas he formerly sold from five to ten carloads a year.

The book on how to make cement roads, that which tells how to make cement telegraph poles, and others which tell how to make concrete coal pockets, and so forth, are all doing their work, but the supply of cement is not yet on a level with consumption. The mills can make more than the people can use. It costs a great deal of money to keep a plant running. It is practically ruin to let the concern's organization disband. The plant must be operated day and night; week day and Sunday. To cool the kilns means heavy losses, so they have to be kept hot.

LOOKING TO THE FOREIGN FIELD.

American cement ranks with the best of any other country, but American manufacturers cannot place it outside of this country. The exports last year were 2,340,000 barrels. This is based upon a shipment by one company of "a little over 2,000,000 barrels" to the Panama Canal. (The exact figures are computed at 2,100,000 barrels.)

Of this amount only 340,000 barrels, approximately, went to foreign ports. As the Panama Canal work is an American operation on American soil, this company's shipment cannot be correctly classed as foreign business. There are 103 companies in the country, which gives an average of only 2,200 barrels export business for each. Germany alone sent 99,714 barrels into this country during eleven months of 1910, and 200,197 for the same period in 1909. The value of the 1910 shipments totalled $144,477 and the 1909 shipments $307,924. Note the difference in these values as compared with American values.

The imports of Portland, Puzzolan and other cements during the eleven months of 1910 are shown in the following table:

	1909 Barrels.	1909 Value.	1910 Barrels.	1910 Value.
Unit'd Kingdom	6,584	$9,262	26,364	$29,894
Belgium	95,112	120,207	116,002	151,525
Germany	200,197	307,924	99,714	144,477
Canada	48,342	92,625	6,193	9,006
Scattering	34,781	52,636	22,345	31,657
Total	385,016	$582,654	270,618	$366,559
Foreign cement exported	4,197	6,312	16,970	23,653
Net total	380,819	$576,342	233,648	$343,906

Decrease in imports during eleven months in 1910 over same period in 1909, 127,171 barrels.

American exports should greatly exceed any of the totals for other countries. The German Portland Cement Manufacturers' Association has a membership representing 29,600,000 barrels for the country's output last year, with 96 registered factories. America had 103 factories last year, an output of 74,000,000 barrels and an actual export business for eleven months of not more than 126,000 barrels.

Portland cement probably never will advance above the present current price at mill, but the cost of manufacture will be considerably lessened. This will come only by increased capacity. If this increased capacity does not find an outlet the law of supply and demand will affect prices and cement will be cheapened to the home consumer at the expense of the manufacturer until he is forced to go out of business.

The One-piece House

(*Continued from page 277.*)

type of house, but does not carry the high quality that an all-concrete home does. Its cost is low in small houses. Where several practically alike can be put up at the same time costs have been obtained which were nearly the same and in some instances less than a first-class frame house.

The construction of these concrete wall houses is a matter of careful study and experimentation by small local builders, and by architects who are enthusiastic and interested in trying to do away as far as possible with the terrific fire loss in this country. Mr. Edison's much-talked-of cast iron forms for the workman's home have not as yet been found practicable. There has never been an Edison house built, and in the opinion of most practical concrete men, none ever will be built. The problems of handling concrete as proposed by Mr. Edison seem insurmountable. The initial cost of preparing such a set of forms as proposed by Mr. Edison entails all told, including contractor's plant, materials and all other items entering into the financial outlay, about one hundred and seventy-five thousand ($175,000) dollars. The Morrill house, which won the prize at the Tuberculosis Congress a year or so ago, has been successfully built in several instances at costs which are very low. It is essentially

a very small house of the simplest interior and exterior treatment and offers an interesting field for further study. The low costs which have been obtained in the Morrill houses thus far built have been due to very low prices for materials which have been obtained locally and under especially favorable conditions. The special feature in the Morrill system seems to be a series of sheet iron forms or molds which are made interchangeable. The advantage of these molds is not apparent to most concrete builders. It has been found that similar work can be done as economically, and probably more so, by using ordinary wood forms made of panels so that they are easily handled by workmen. At Forest Hills, Long Island, the Sage Foundation Homes Company is doing some experimenting with concrete workmen's cottages on a large scale, and it is hoped that with the large resources available, a simple concrete house can be worked out which will be all concrete and well within the reach of the small moneyed man. At present this is not the case, except for houses with walls only of concrete.

Ornamental Concrete

(*Continued from page 284.*)

as a building material to which it is entitled when properly made.

Assuming from what has been said that concrete can and has simulated natural stone very closely in appearance, and assuming further that the appearance of natural stones is pleasing and desirable, it follows that concrete has great possibilities ornamentally, and we shall therefore take up the matter of designing in this material.

Concrete is primarily a plastic substance and should be so considered in designing. It has its limitations and should not be used where another material would serve the same purpose and be cheaper. It can be treated artistically to suit itself alone—as a particular material—different from brick or stone or wood, and this is the principle we must bear in mind in developing its artistic possibilities. A practical knowledge of its physical qualities and how to make it good, strong and durable and to work it economically is necessary. This requires a large practical experience and much time. Laboratory experiments are often very misleading, good examples being easily made and work on a small scale often impracticable on a large one. In cement exhibits, for example, concrete samples are frequently shown, illustrating beautiful balustrades, statuary and other attractive objects made of concrete which cost a great deal more than supposed, and are of questionable durability when exposed to the elements; panels showing surface treatments most impracticable of reproduction on a large scale, some perhaps one foot square on which one or more hours' labor of a skilled, high-priced man was required working under conditions not to be found in actual work. In some cases the results are obtained by casting the pieces in a horizontal position, face up, while in actual practice they would have to be cast vertically and in large area. In other cases the concrete has been covered with a veneer that is apt to peel off or craze if exposed to the weather. Many of these "tricks of the trade" must be known. The writer has in mind the case of one of the largest cement manufacturers in the country that has made a practice for the last two or three years of exhibiting on a quite extensive scale at different "cement shows," examples of concrete products made of course of its own cement, and has carefully shown only work that was genuine and that could be produced actually in practice; but it is doubtful if one out of ten persons who have seen these exhibits knew the difference or appreciated the honest and far-seeing policy of the company in showing what was actually practicable.

Excluding lack of taste, most of the badly designed structures built of concrete that are so common in this country, are the results of ignorance, either of the possibilities of the material, or of its limitations.

The International Aviation Race for the Bennett Trophy.—The date of the International Race for the Bennett Aviation Trophy has just been set by the Royal Aero Club of Great Britain. The race will be held in England on June 28th, and will be over a circular course above an aerodrome. The distance is 150 kilometers (93 miles). America, Austria, France and Germany have challenged for this race, and will send teams of three aeroplanes each.

Aeronautics

Scouting by Aeroplane on the Mexican Border.—The new Wright biplane, which was loaned to the War Department by Mr. Robert Collier, was put in commission recently at Laredo, Texas. On March 1st Aviator Parmalee took up a photographer, while Lieut. D. B. Foulois made five scouting flights later in the day with the Wright pilot. The aeroplane was stationed at Fort McIntosh, from which point the 116-mile flight was made on March 3rd.

Gnome Motors for America.—A contract was closed last week by Mr. Robert Taylor, of New York, for ten Gnome motors, to be supplied by the Societie Gnome, of Paris, within a couple of months. Mr. Taylor expects to use these motors on some aeroplanes he is constructing, and he will also dispose of a number of them to individuals. This is the first large shipment of this well-known aviation motor to America, and it should result in some record flights by such aviators as are fortunate enough to get one.

Successful Flights by Curtiss' Military Pupils.—On March 2nd, four of the officers of the Army and Navy detailed to be taught how to fly by Glenn Curtiss made successful half-mile flights at San Diego. Lieut. Paul W. Beck, of the Signal Corps, led off with a half-mile flight in a straight line. He alighted, and then flew back to the starting point. Lieut. Theo. G. Elliston, of the Navy, and Lieuts. John C. Walker, Jr., of the Eighth Infantry, and Geo. E. M. Kelley, of the Thirteenth Infantry, also made similar successful flights.

A Record Oversea Flight.—The longest and most remarkable flight ever made over water was accomplished by Lieut. Bagne (who recently resigned from the Fourth Algerian Rifles to take up aviation) on the 5th instant. Starting from Nice in his Blériot monoplane at 7:30 A. M., Lieut Bagne headed for Corsica, but lost his way, and after flying continuously for 5½ hours, finally alighted upon a small rocky and wooded island named Gorgona, lying between Corsica and Leghorn, Italy. His machine was badly damaged in alighting, but the young officer escaped without injury. The air line distance covered was about 125 miles, but the actual distance was fully twice as great. It was Lieut. Bagne's intention to fly entirely across the Mediterranean to Algeria via the islands of Corsica and Sardinia.

An Amphibious Aeroplane.—On February 26th, Glenn H. Curtiss made his first flight at San Diego with his new biplane, equipped with both a pontoon and with wheels. He was able to start from the land, alight on the water, re-start from the same, and alight on *terra firma* once again without mishap. Now that he has accomplished this feat, there is nothing more to be desired, since he has produced a machine that can be used on land, water, or in the air. The aeroplane was mounted on a single scow-shaped pontoon as before, but Mr. Curtiss has added three wheels such as he uses on his ordinary biplane intended for flights over land alone. He believes that much of the flying will now be done over water, and that many of the disused canals will have to be put in order again to provide safe highways over which aviators can fly and upon which they can alight in case of emergency.

The Winning of the Michelin Trophy for a 222-mile Cross-country Flight.—On March 7th Eugene Renaux, a new French aviator, won the $20,000 Michelin Prize for a flight with a passenger from Paris to the summit of the Puy de Dome mountain, some 222 miles away. The trip was made in 5 hours and 8 minutes elapsed time. A deduction of 17 minutes for a stop at Nevers makes the actual time in flight 4 hours and 51 minutes, which corresponds to an average speed of 45¾ miles an hour. The flight was made with a Farman biplane, and in accordance with the rules the aviator circled the Arc de Triomphe at Paris before starting and the spires of the cathedral at Clermont-Ferrand at the finish. The landing, upon the summit of the 4,805-foot-high mountain, was made successfully despite a spot only 120 by 300 feet in size upon which to alight. The flight was made under perfect weather conditions, but half an hour after its completion the mountain was obscured by fog. The only two other attempts to win this prize were made by the Morane brothers in their Blériot monoplane, and Weymann in his Farman, last summer. The latter got within 10 miles of his destination when he became lost in the fog and was obliged to alight.

Electricity

Day Letter Telegrams.—Night letter telegrams have proved so successful that a day service has just been inaugurated, the letter to be sent at reduced rates at some time during the day convenient to the sending company.

Ripening Bananas by Electrical Heat.—Experiments have proven that bananas may be ripened to the best advantage by subjecting them to a dry heat of seventy-five degrees in an air-tight room. Recently electrical apparatus has been employed for producing the necessary heat in a ripening room, and the heat is kept constant by means of thermostats.

Utilization of Water Power in Switzerland.—The Swiss Industrial Water Union estimates that 60 per cent of the total water power of the country is used for generating electricity. This is a much larger proportion than in any other country in the world. The water power of Switzerland is rated at 1,200,000 horse-power, and this year 700,000 horse-power will be used by electric power stations.

Ice Cream Plant as an Adjunct to a Power Station.—Recently electric power stations have found it profitable to manufacture ice during the slack season in order to equalize their power production the year round. Another step in this direction has just been made by an electric light station in Nashville, Illinois. A refrigerating plant has been installed capable of producing 80 tons of ice per day, and in addition to this an ice cream plant has been established capable of manufacturing 40 gallons of ice cream per day.

Wireless Automobile Outfit for the German Army.—The German army has recently decided to adopt an automobile wireless outfit of a very good design. It will be used with each division of cavalry and carries six men and a set of wireless apparatus. A telescope mast is carried which can be set up in place in the ground in a few minutes and anchored steady before connecting a wire to the automobile outfit. Six minutes after the car stops the apparatus is ready to send signals. It has an effective radius of 100 miles.

Fighting Corrosion with Electricity.—It is largely because of electro-chemical action that boilers become corroded, and to overcome this, it has recently been suggested that currents of electricity be set up in such direction as to negative this electro-chemical action. Successful tests of this system have been conducted in Australia, and now the Canadian Pacific Railroad is planning to use electricity for the protection of the boilers of its engines in regions where corrosion has been particularly annoying. The amount of current required for fighting corrosion is very small, and this method of combating the destructive action of chemicals in boiler water may be conducted very economically.

Measuring Gas by Electricity.—A novel gas meter has recently been invented, in which the flow of gas through the meter is determined by the quantity of heat necessary to raise its temperature by a definite amount between two fixed points where thermometers are placed. The gas current is heated by an electric coil, and the thermometers for measuring the heat at opposite sides of the coil consist of fine resistance wires forming the arms of a Wheatstone bridge. The advantage of this scheme is that the recording mechanism may be placed at any desired position, for instance, in the general office of the gas company, even though it may be a mile or more from the gas works. The meter consumes one kilowatt-hour for a flow of 75,000 cubic feet of gas.

The Development of Electric Railroad Lines in Italy.—Electric railroad work is very active in Italy at the present time. Some of the lines will use current from hydraulic plants. Traffic will soon commence on the Mont Cenis Railroad line, and the Chimonte hydraulic plant is to furnish the current. Another electric railroad is the Giovi line in the region of Genoa, and it is also to be opened shortly. One of the highest electric railroads in Europe to use adhesion is the new Bernina line. It passes over the Bernina Pass at 7,700 feet altitude in order to connect the Albula and Valtelline lines in the Italian lake region. Current comes from the great Brusio turbine plant. We should also mention the projected line from Rome to Frosinone, which will be about 80 miles long. In the south of Italy a 60-mile electric railroad is to run from Naples to Avellino.

Engineering

Guns Win Against Armor.—The Navy Department considers that the results obtained in the recent "Katahdin" target experiments are very encouraging. Of ten 12-inch shells fired at a range of 8,000 yards, with an initial velocity of 2,400 feet a second, four hits were recorded, and the 8 and 10-inch curved plates were completely penetrated. The more modern guns of 50-calibers length, therefore, seem to have the latest battleship cruisers, with their 8 to 10-inch armor, completely at their mercy when within range.

Imported Australian Railway Ties.—A consular report states that 70,000 railway ties of what is known as Tasmanian oak, a species of Eucalyptus, have been shipped to the United States, and other shipments are to follow. Forest roads laid with this timber over fifty years ago are found to be still sound. In gravel ballast and under a rainfall of 20 to 60 inches, these ties will last fifteen years; indeed, after twenty years of use, they have been found to be in good condition. So hard is the wood that, even on curves, tie plates are not necessary.

Value of Compounding and Superheat in Locomotives.—The Lancashire & Yorkshire Railway, England, has made a valuable addition to our knowledge of the value of superheating and compounding in locomotives. In a series of tests of compound versus simple locomotives, on the basis of time and total coal and oil per train ton-mile, there was shown a maximum increased percentage value of the compound over the simple, of 16.4 per cent; and in another test of non-superheater and superheater freight locomotives on a similar basis, there was a maximum increased percentage value for the superheater of 34.1 per cent.

Fast European Express Trains.—Express speeds in Great Britain and on the Continent are high. In Great Britain there are eleven daily express trains making runs of from 50 to 118⅜ miles without a stop, whose average speed is from 51 to 59.2 miles per hour. The fastest and longest non-stop run is 225¾ miles, from Paddington to Plymouth, made at 54.8 miles per hour. France has seven daily expresses that run from 77¾ to 147½ miles without stop at speeds of from 51.1 to 61.8 miles per hour, and there are nine French trains that run from 102 to 147¾ miles without stop at speeds of from 50.4 to 59.3 miles an hour.

Strength of Wood After Long Service.—Evidence that structural timber, if properly protected, does not deteriorate in ordinary service is afforded by some white pine beams, which formed the chords for a timber bridge during eighteen years of service, the bridge being covered during fourteen of these years. Tests of the timber showed an average elastic limit of 3,966 pounds, and a modulus of rupture of 5,208 pounds per square inch. According to W. K. Hatt, of Purdue University, who records these facts in *Engineering News*, white pine beams of large size are credited with an average modulus of rupture of 5,000 pounds per square inch.

Panama Canal Tolls.—It is proposed in Congress that the tolls through the Panama Canal shall be based on tonnage, and shall vary from 50 cents to $1.50 a net ton. In order to stimulate the construction of American shipping for service through the canal, the lower rate may be accorded to vessels of the United States and of Panama. To neutralize the competition of the railroads, there is a provision prescribing that any coastwise trade vessel owned by any railroad company, or any company whose stock is controlled, etc., by any railroad company, or which is controlled directly or indirectly by any railroad company, etc., shall pay the highest rates authorized by the bill.

Bituminous Material Checks Road Destruction.—Testimony to the great road-preservative value of a bituminous binder is found in the report of the State Highway Commission presented to the New York Legislature, who ask for $40,000,000 in addition to the $50,000,000 already authorized, to complete the State and county system of improved highways. A top or binding course of bituminous material, says the report, has been found not only to withstand the destructive action of motor vehicle tires, but to eliminate the dust nuisance. This method, coupled with a system of rigid inspection and patrol, makes it possible to maintain the public roads at a reasonable annual expenditure.

Science

Wherein Coal Resembles Ice.—Coal, petroleum and illuminating gas are related to one another much as are ice, water and steam. For this reason, perfect combustion of liquid fuel is already advanced a long step toward vaporization, just as ice is advanced toward steam when turned into water. The volatile elements of coal are locked up in the solid form, or virtually frozen solid. Dewar demonstrated how great an amount of heat must be taken from the so-called permanent gases to make them liquid, and how much more to make them solid. Yet Nature has solidified gas into the form of coal, and solid coal, like solid ice, will dissolve into vapor only through the expenditure of heat.

Preparation of Colloidal Solutions.—Colloidal solutions of metals have been obtained by numerous processes, most of which are based on the reduction of metallic salts by various reagents in special conditions. The production of such solutions possesses practical as well as scientific interest, as colloidal solutions of several metals, especially silver, have been employed in medicine. Svedberg has indicated a new method of preparing colloidal solutions by the disintegrating effect of ultra-violet rays on metals. The metal, the surface of which should be entirely free from oxide, is covered with a thin layer of liquid and exposed to the rays of a Heræus lamp placed an inch or two above the liquid. In these conditions colloidal solutions are easily obtained from silver, copper, tin and lead, but not from platinum, aluminium or cadmium. Experiments made with silver and lead, immersed in water ethyl alcohol, isobutyl alcohol, ether, acetone, ethyl acetate and amyl acetate, show that the number and the dimensions of the colloidal particles vary greatly, according to the nature of the liquid employed.

Helium and the Age of Rocks.—Recent theories of the evolution of radium have been ingeniously employed for the computation of the age of rocks. Strutt has given a very simple formula, according to which $9.13 \times 10\text{-}8$ cubic centimeters of helium are produced annually per gramme of uranium peroxide (U_3O_8). This result makes it possible to reduce from the chemical analysis of a numeral the number of years which have elapsed since its crystallization. This method, however, is open to numerous objections, and its value appears to be entirely destroyed by evidence recently contributed to *Radium* by Piutti, who shows that fused minerals may absorb helium gas. Part or all of the helium found in minerals, therefore, may have been imprisoned before their solidification. This result explains the presence of helium in stibine and other non-radioactive minerals. As, on the other hand, a temperature of 750 deg. F., to which rocks must often have been subjected since their solidification, is sufficient for the extraction of the greater part of their helium *in vacuo*, the quantity of helium found in them bears no definite relation to their age, and can only be used to determine roughly the average age of a well characterized group of minerals.

Boots and Coffee.—In Germany, in the eighteenth century, two afterward common things were regarded as great luxuries. A man who wore boots instead of shoes ran the risk of being regarded as a fop, and a coffee drinker incurred the reproach of prodigality and gluttony. The enjoyment of these luxuries by clergymen was especially condemned. A diatribe written by a pastor in 1740 and quoted in a recent issue of *Hygieia*, contains the following: "The household expenses of country pastors have greatly increased. In the early part of this century a parson in boots was a rare sight. A man who always wears boots must pay his shoemaker twice as much as in the old days when clergymen were contented with shoes. And there is another expense for coffee, the very name of which was unknown in former times. It is no exaggeration to say that this outlandish drink cost 100 gulden a year. It was adopted by the Turks and Moors because wine is forbidden to them, but why the Germans, who have so many lawful beverages, have chosen coffee as their favorite, is to me inexplicable. In some households the expense is diminished by mixing various things with the coffee, but even if we grant that many a country parson spends only 50 gulden a year for coffee, with sugar and milk, this is a large sum for a man having a yearly income of 400 gulden to expend for the satisfaction of a formerly unknown want."

Artists' Mistakes

IN a noted picture exhibited not so long ago the artist, well known for his ability to "hold up the mirror to nature," nevertheless made a curious error, which he would not have committed had he taken the trouble to acquaint himself with certain habits of the beast he portrayed in that picture.

A tiger is shown slaking its thirst at a stream. The artist does not show much more than the head of the beast, and it is life size; but he made the blunder of burying the mouth of the creature far below the surface of the water, making it drink as one may see a horse any day drinking at a trough, and not lapping up the liquid like a cat, as of course a tiger would. It is curious to understand how an artist who could paint well enough to command for his picture a place on the walls of an important exhibition, could make such a fundamental mistake.

Another example, shown at the same exhibition, displayed a dove with outstretched wings. A student of animal mechanism looking at that picture, remarked that it was very pretty and poetical in idea, but that by no possibility would a bird thus constructed be able to fly.

Mistakes of this kind were common enough in past times, when there were no zoological collections for study, and when artists had to depend upon travelers' tales for their information regarding foreign animals. Until the time of Cuvier, these pictorial monstrosities were the rule and not the exception.

Some years ago a leading scientist pointed out that painters were liable to fall into errors of another kind through ignorance of the elementary laws of optical phenomena, and he gave them many valuable lessons and warnings. It was shown that, although geometry had been applied to perspective and anatomy to form, artists as a class seemed to have come to the conclusion that the phenomena associated with air, sky, and sea need not engage their attention. For example, there was the case of a capable painter who pictured a rainbow inside out! When the work was returned to the artist for correction, he was so much disgusted with what he regarded as a preposterous demand that he charged one hundred dollars for replacing the colors of the bow in their proper relative positions. Another painter had the temerity to place a crescent moon in the eastern sky directly opposite to a setting sun. When the fault was demonstrated to him, he defended his action on the ground that if he had painted the moon full, as it certainly would have been in nature under such conditions, it would have upset "the balance of the picture."

This artist was by no means the only one who has fallen into a mistake with regard to the earth''s satellite.. Examples might be quoted in which the new moon had its convexity turned away from the sun, which is, of course, an impossible state of things, as one may test for himself by experimenting with an orange and a lighted candle. Sometimes too the moon has been represented close to the constellation known as the Great Bear, a part of the heavens which it has never been known to invade. Then the size of both the moon and the sun as represented in paintings has often given rise to protests from those whose words are worthy of heed.

A distinguished astronomer once took the trouble to measure in several paintings the size of the moon, and to deduce from it the height of the mountains shown in the same picture. He found that the average height of the hills was about forty-three miles, while one giant peak raised its head more than one hundred miles above sea level!

It would, of course, be absurd to tie an artist's hand, and to say that every touch of his brush must be made with scientific accuracy. The imaginative faculties must have play, or we should have no pictures worthy of the name. Turner, who was one of the greatest masters of landscape composition and coloring, frequently exaggerates the heights of his hills with the intention of conferring upon them a majesty which otherwise they would not possess.

If mistakes are possible to artists in these advanced times, when every branch of knowledge is specialized, and when it is so easy to obtain encyclopedical information, it is not surprising that errors of a far grosser kind were committed by the painters of past centuries, whose learning was necessarily limited by their environment.

The most common errors were brought about by confusion of period, by which the affairs of centuries apart were dovetailed and blended in the most curious fashion. In the early works of the German, Flemish, and Dutch artists are found both anachronisms and incongruities in plenty. That the Garden of Eden should be painted by a Dutch artist as having well-clipped borders and yew trees cut in quaint devices is excusable, for the draughtsman was unacquainted with any other type of garden. In 1794, we are told, there was a picture to be seen in a Dutch village in which Abraham appeared ready to sacrifice his son Isaac by a loaded blunderbuss. This would antedate the use of firearms by more than three thousand years.

Pictures are shown of the Israelites crossing the Red Sea, armed with muskets of comparatively modern date.

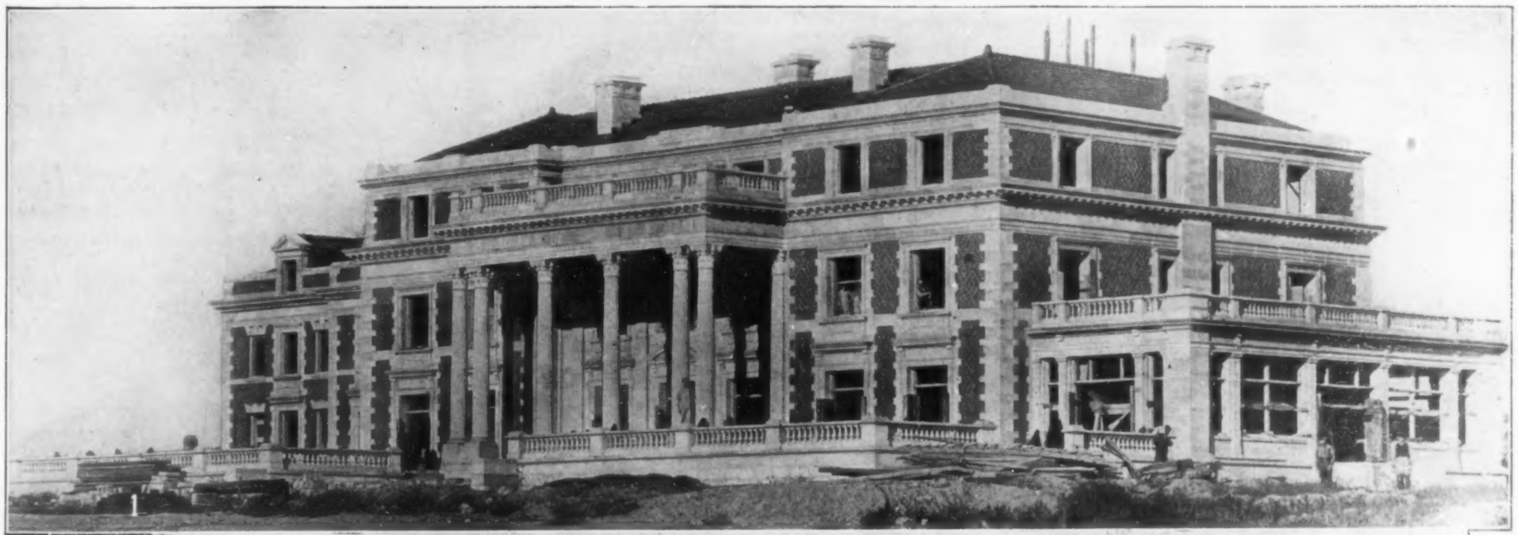
It is in the matter of costume that the early painters found such a stumbling block, and there is no difficulty in seeing how this arose. They painted the scenery and dresses of such widely different countries as Palestine and Egypt without having any knowledge of those places or any opportunity of acquiring reliable information. In the National Gallery at Edinburgh there is a picture in which Pharoah's daughter and her ladies are attired in the long-waisted bodices and hooped skirts peculiar to the sixteenth century European woman. In another picture of the same date, representing Joseph and his kindred in Egypt, which is hung in the National Gallery in London, there is no trace of the distinctive features of Egyptian architecture about the buildings; they are all Italian in type.

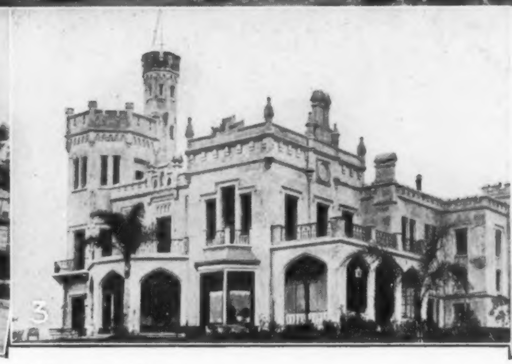
It was impossible for even such a genius as da Vinci to know that a table, a spotless table cloth, plates, knives and forks, to say nothing of salt cellars, were wrongly introduced into one of his most famous works, and that the Eastern people whom he painted used neither tables nor chairs, but squatted around and ate from one dish.

In more recent times we find that anachronisms of costume and scenery were as common little more than a century ago in dramatic representation as they were in the pictures. In a portrait of Mrs. Hartley in the character of Cleopatra, she is dressed in a hooped petticoat, over which is a pannier skirt and a long train, the skirt being adorned with festoons of roses. Her waist is confined in the stiffest of corsets, while she wears on her head an earl's coronet, surmounted by an ostrich plume. It would require the pencil of one of the world's famous caricaturists adequately to express Anthony's surprise when he saw his Cleopatra arrayed in such fantastic style.

And it would not be the first time that a picture had been caricatured by reason of some incongruous feature. For instance, there is a well-known picture of Napoleon crossing the Alps. This subject has been quite a favorite theme with artists; but the particular example referred to shows the Emperor in gorgeous costume, mounted upon a richly caparisoned steed, which is prancing with delight at the august burden which it is honored by carrying. Such is the romantic idea of the event as it was presented to the mind of the imaginative painter. The caricaturist has given us a far more prosaic representation of Napoleon's famous journey. It is snowing hard, and the Emperor, so closely wrapped in his cloak as to look like a mere bundle of rags, is crouched upon the back of a wretched mule. A tall chasseur, as lean as the poor mule, grasps the animal by the tail with one hand and flogs it with the other. The caricature is probably far more historically correct than the more serious work.

Powerful Armored Cruiser for Japan.—There is now under construction at Barrow, England, for the Japanese Government, a large armored cruiser of the dreadnought type, which, it is reported, will be the largest and most powerful vessel of her kind. Her reputed displacement is 28,000 tons. The whole of the work on this vessel, including armor and armament, will be done by the contracting firm.





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2.—Home at Paisley, Scotland, suburb of Glasgow—Built entirely of Ideal blocks.

3.—Palace of Senora De Tomba, Mendoza, Argentina—Stucco applied on Ideal blocks.
4.—Home of Judge Smith, of Ottawa, Canada—Built entirely of Ideal blocks.

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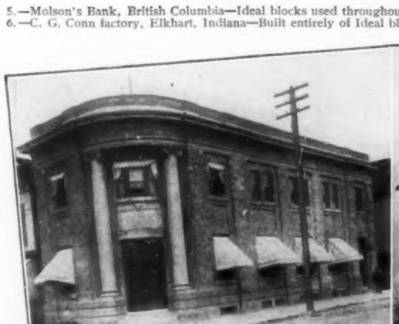
6.—C. G. Conn factory, Elkhart, Indiana—Built entirely of Ideal blocks, stucco applied.

7.—Switch Tower of Ideal blocks, Lake Shore & Michigan Southern Ry., La Porte, Indiana—The type adopted by this road—Twelve already built.



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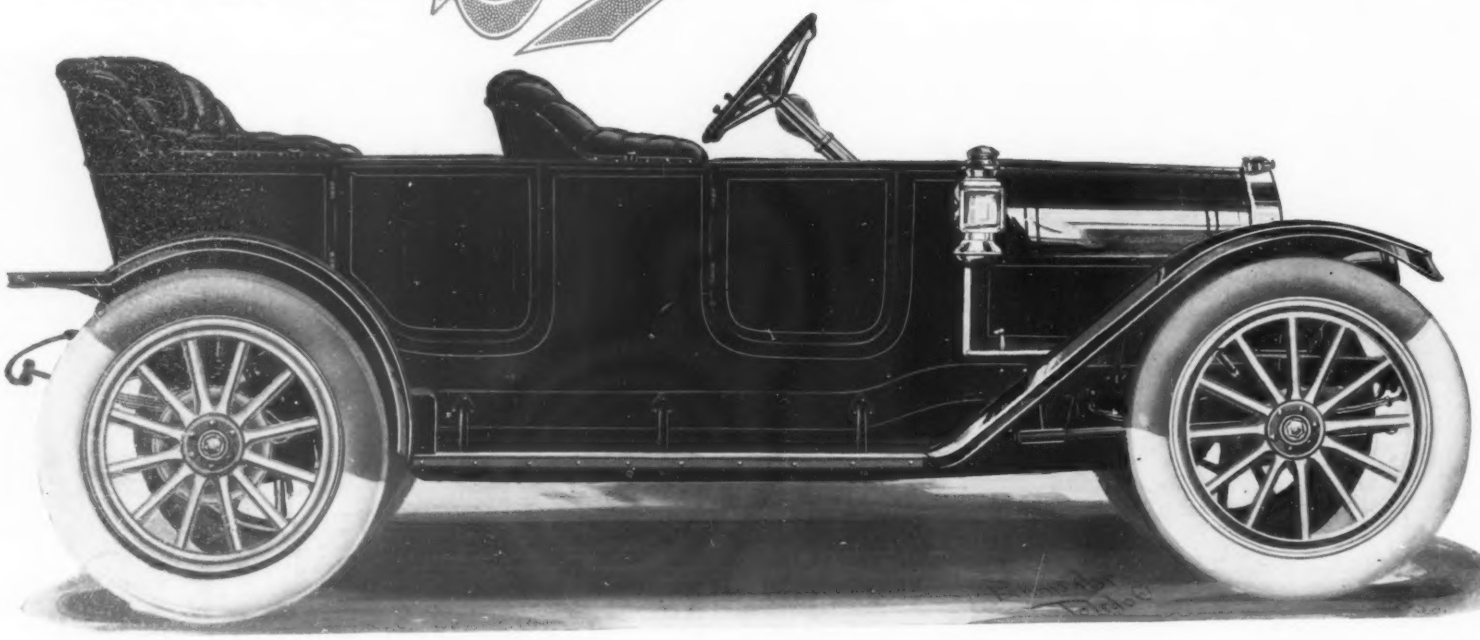
¶ The plants of the Willys-Overland Co., are the largest, most complete and best equipped. The Toledo plant alone covers over 30 acres. The five Overland chassis are absolutely standardized. No maker in the world works to closer limits in fineness of fit.



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118 inch Wheelbase, $1,600

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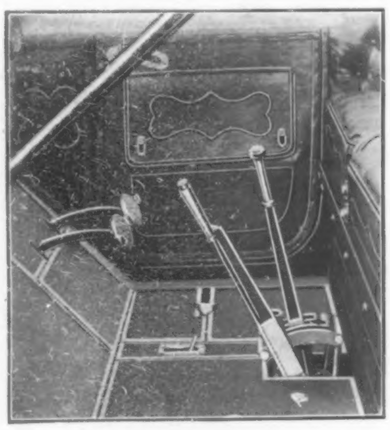

This illustration shows the centre control of the ***Overland***. We wish to lay particular stress on the fact that Overland Fore Door Models are designed and built as original Fore Door cars—not old bodies made over to meet the prevailing style. Centre control is the very latest and most approved and practical type, both at home and abroad.

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¶ Compare the springs and riding qualities, the speed, the hill climbing ability, the wheelbase, the frame, transmission, brakes, rear system, size of wheels and axle, steering gear. Compare the finish, upholstery, the body design and workmanship. You'll find that *Overland* fore door models are designed and built as fore door models, not old bodies patched up to meet the prevailing style, with shifting lever and emergency brake outside and out of reach. See the detail cut to the left, showing *Overland* centre control, the approved practice in all up-to-the-minute, high-class cars.

¶ Consider, and bear this point in mind *always*, that the *Overland* is a *manufactured* car, every part and every piece made by us, after our own designs, by our own men, in our own plants.

¶ You'll find, too, that the *Overland* is a thoroughly standardized car. Each operation on every part is made by an expert workman on that particular thing, by special machinery in a special "jig," from the best material.

¶ Each cylinder, gear, shaft, bearing, axle, frame, transmission, body, etc., etc., is *exactly* like the other in the same *Overland* chassis. No fitting, grinding or filing is necessary or permitted in the final assembly.

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¶ We could make them more extravagantly, but we cannot make them better.

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